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THE ASTROPHYSICAL JOURNAL

AN INTERNATIONAL REVIEW OF SPECTROSCOPY AND ASTRONOMICAL PHYSICS

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AN INTERNATIONAL REVIEW OF SPECTROSCOPY AND ASTRONOMICAL PHYSICS

VOLUME LXXI JANUARY 1930 NUMBER 1

THE SPECTRUM OF THE CHROMOSPHERE

BY S. A. MITCHELL

ABSTRACT

Discussion of spectra obtained at total solar eclipses.— A *revision* of the spectrum of the chromosphere is carried out by the methods followed in the *Revised Rowland*. The spectra utilized are mainly those of the eclipses of 1905 and 1925, secured by means of gratings without slit, the scale of wave-lengths being 1 mm = 10.8 A. At the extreme ultra-violet, owing to the kind permission of Davidson and Stratton, a region of 250 A from their 1926 measures is included.

The range of wave-lengths investigated is from λ 3066 in the violet to λ 7065 in the red, or 4000 A. The *Revised Rowland* begins at λ 2975, or less than 100 A farther to the violet.

The flash spectrum gives information of two kinds regarding the sun in addition to that found in the *Revised Rowland:* (1) the *intensities* in the emission spectrum of the chromosphere, and (2) the *heights* or *levels* above the photosphere reached by the atoms forming each spectral line.

Marked differences between solar and chromospheric intensities estimated on the Rowland scale, are found, that of the sun resembling the arc, while that of the flash agrees more closely with the spark.

Heights above the photosphere.—Levels in the chromosphere are derived from the lengths of the crescent arcs in the slitless spectra. A close correlation is found between increased strength of lines and increase in height above the photosphere. With the rise of level there is a slight falling-off in temperature, but a very rapid decrease in pressure compared with conditions found at lower levels. At the higher levels ionization can take place more readily. The greatest heights in the chromosphere are reached by Ca^+ at 14,000 km.

Theory of ionization.—The information derived from the increased strengths of the enhanced lines, corresponding to increased elevations and diminished pressures, was utilized by Saha to verify his remarkable theory of ionization.

Connection between sun-spots and solar activity.—Comparisons are made of the heights from the 1905 and 1925 eclipses. The former eclipse took place near maximum of spots and with the sun presumably at greater activity. The 1925 eclipse occurred 1.5 years after sun-spot minimum. From comparisons of the two eclipses, it was found that for the lines of greatest level, those reaching heights of 5000 km or more, there is a close agreement between the results of the two eclipses. For the lines of medium level, lying between 1000 and 2500 km, the 1905 heights show the surprising result that they are less than in the year 1925. As the emission lines of coronium were stronger in 1925 than in 1905, the conclusion is drawn that the spots appearing in high northern and

southern latitudes about the time of spot minimum are the cause of the great activity found in the 1925 eclipse.

In a further communication, *correlations* found to exist *between the intensities* both in the sun and in the chromosphere, and *heights* and *excitation potentials*, will be discussed for the separate elements. A knowledge of the heights above the photosphere at which lines of different elements originate has a very important bearing on the interpretation of the results of solar investigation, particularly in the Einstein relativity effect, in the Evershed effect observed in sun-spots, in solar rotation determined spectroscopically, etc. Some of these matters will be discussed in the sequel.

In recent years the combined attack on atomic structure by the physicist, chemist, and astronomer has resulted in a vast increase in knowledge of the spectra of the elements, including the analysis of multiplets, series, and electron configurations. This new information has been of vast service in the *Revision of Rowland's Tables of the Solar Spectrum* carried out with such consummate skill at the Mount Wilson Observatory.

The sun is the only one of the fixed stars for which a reversal of its spectrum may be observed, and this is rendered possible at the time of a total eclipse. The history of the investigations carried out on the flash spectrum since its discovery in the year 1870 is treated fully in *Handbuch der Astrophysik*, **4**, 275–315, 1929.

In view of the magnificent work accomplished both on the spectrum of the sun and on the spectra of the elements, it has seemed desirable to carry out a revision of the spectrum of the chromosphere, utilizing for the emission spectrum the same methods as are employed by St. John and his collaborators on the absorption spectrum, the results of which are found in the *Revised Rowland*. The spectra of the chromosphere employed for the purpose are mainly those obtained by the writer at the eclipses of 1905 and of 1925.

The spectra of the 1905 eclipse were secured in Spain while I was a member of the United States Naval Observatory Expedition. The photographs of the flash spectrum were obtained by two different grating spectrographs, each used without slit. One of the gratings was concave, of 10-foot radius, ruled with 14,438 lines per inch, the so-called "parabolic" grating of 4-inch aperture. The other was a plane grating of 15,000 lines per inch and 6-inch aperture. The discussion of the spectra is found in the *Astrophysical Journal*, **38**, 407, 1913, in *Publications of the Leander McCormick Observatory*, **2**, Part 2, and also in *Publications of the U.S. Naval Observatory*, **10**, B, 32–116, 1924.

The photographs utilized for the published discussion were two

only, the second flash secured with each spectrograph. With the parabolic grating a total of eleven spectra were photographed, all of them in good focus. In the present revision other photographs, in addition to one from each instrument already discussed, have been utilized for deriving the final conclusions.

At the 1925 eclipse, the parabolic grating was again kindly loaned by Professor F. A. Saunders, and successful photographs of the flash spectrum were secured at Middletown, Connecticut.

At the 1905 eclipse the region of wave-lengths discussed (*loc. cit.*) extended from λ 3318 to λ 6191. In 1925 the region photographed was from λ 3300 in the violet to λ 7065 in the red.

In order to make the present revision more complete, additional photographs were utilized at the ultra-violet end of the spectrum. Dr. J. A. Anderson, of the Mount Wilson Observatory, kindly put at the disposal of the author the photographs secured without slit, with a 21-foot concave grating at the 1925 eclipse. Anderson's flash spectrum extended about 100 A farther to the violet than the author's published wave-lengths. Owing mainly to poor seeing, Anderson's photograph of the flash was not in good definition. The results from the measures carried out by the author, while temporarily at Mount Wilson in the summer of 1926, have not been included in the present discussion.

At the 1926 eclipse in Sumatra, C. R. Davidson and F. J. M. Stratton secured photographs of the flash spectrum with exquisite definition extending as far into the ultra-violet as λ 3066, the photographs being obtained with prism spectrograph with slit. The results of their discussion have been published in *Memoirs of the Royal Astronomical Society*, **64**, 105, 1927.

Through their kind permission, the 1926 results are included in the present discussion; and to add further to their kindness a print on glass from the original negative was also furnished. The present revision, therefore, extends from λ 3066 to λ 7065, or a total of 4000 A. It may be added that the *Rowland Revision* begins at λ 2975 in the violet.

SPECTRA INCLUDED IN THIS DISCUSSION

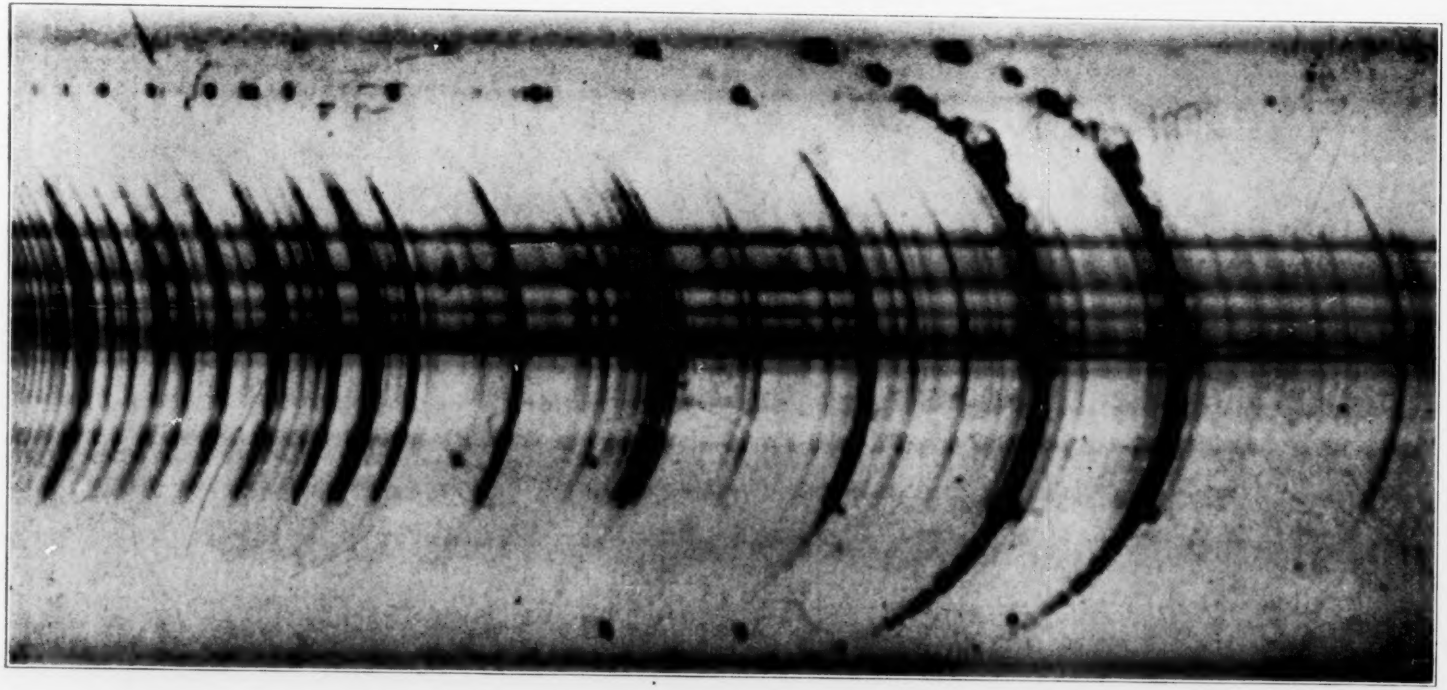
As already stated, other photographs were secured at the 1905 eclipse with both spectrographs which did not enter into the former discussion. Photographs were obtained at the first flash, during to-

tality, and immediately following the second flash. Those taken with the concave grating after the end of totality, with the edge of the sun reappearing, were especially helpful in the present discussion. Judging from the width of the continuous spectrum showing in the photographs, the exposures were made at about one-half second and one and one-half seconds after the end of totality. These spectra taken outside of totality show the photospheric spectrum crossed by the strongest absorption lines, and also by the emission lines. The second of the two spectra taken with the parabolic grating extends even farther to the violet than the limit of wave-length λ 3066 obtained at the 1926 eclipse. The two lines λ 3057.45 and λ 3059.11 of Rowland intensities 20 and 20 appear as strong absorption lines in the 1905 spectra.

At the violet end of these spectra taken after the end of totality the weak low-level emission lines do not appear. Those of greater strength or greater elevation, however, are visible across the continuous spectrum or appear as bright lines beyond the edges of the continuous spectrum. Both of the spectra taken by the parabolic grating after totality were utilized at the violet end to supplement the published information. Similarly, to the red side of the D lines, one additional photograph taken with the plane grating (one-half second after totality) is incorporated into the present revision. Still other photographs, taken during totality with the concave grating, were used to check the heights of the high-level lines. The methods of measurement for the 1905 spectra have already been described in the previous publication. The 1925 spectra were measured by the writer at two different times. The spectra of 1905 and 1925 were nearly "normal," with the result that wave-lengths were obtained from the direct measures with the utmost simplicity.

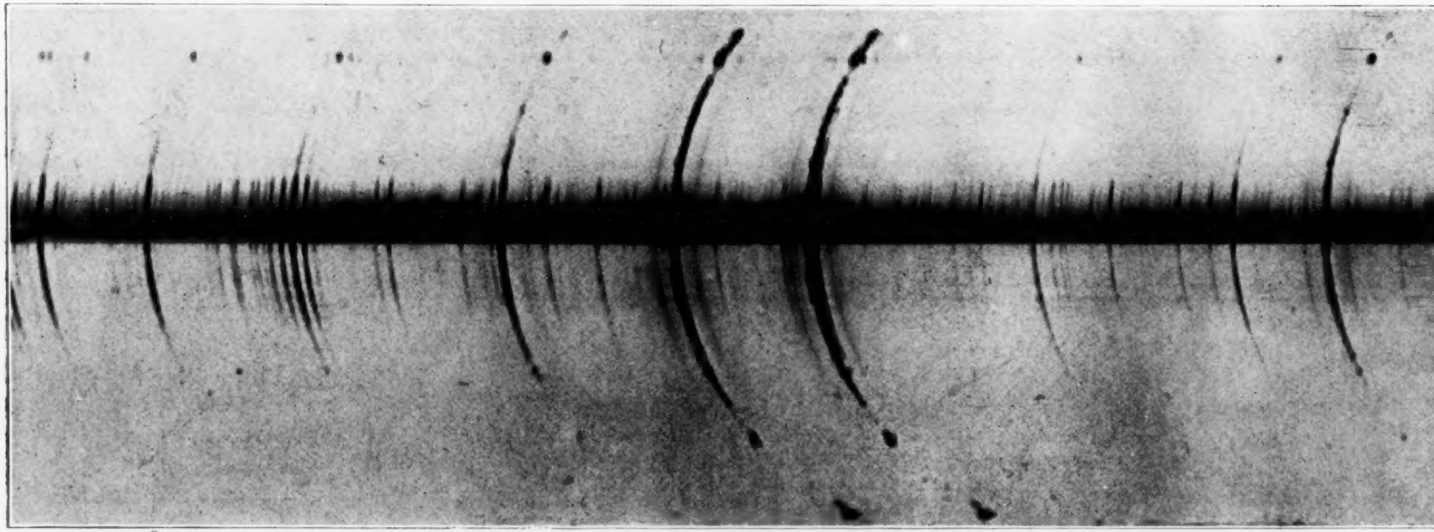
All wave-lengths in the present revision are on the international scale. To the violet side of λ 3318 (the limit of the former discussion) the wave-lengths are taken mainly from Davidson and Stratton. Their wave-lengths, however, were combined with the measures of the 1905 spectra made by the writer; and where differences from their wave-lengths occur, they are explained by the combination of values. From λ 3318 to D_3 (λ 5876), the wave-lengths are a combination of the measures of the 1905 and 1925 spectra, both obtained

PLATE I



THE CHROMOSPHERE IN 1925
Region of H and K and the hydrogen series. Enlarged fivefold

PLATE II



3800 3900 4000 4100

THE CHROMOSPHERE IN 1905
Enlarged fivefold

with the same (parabolic) grating. In 1905 the use of orthochromatic plates determined the limit (λ 5876) of the spectrum photographed. In 1925, Dr. C. E. K. Mees, of the Eastman Kodak Company, coated special films for use at the eclipse with the result that wave-lengths were extended to λ 7065 in the red. In the region from λ 5876 to λ 6191 the wave-lengths are the combination of the 1905 plane-grating spectra and the 1925 spectra, while to the red side of λ 6191 the measures are from the 1925 eclipse alone. At greater wave-lengths than λ 6645, the 1925 spectra showed the stronger of the lines from the overlapping spectrum of the violet of the second order. These second-order lines were of great value in deriving wave-lengths in the first order. Owing to the comparatively small number of lines in the spectrum to the red side of the $H\alpha$ line, the overlapping second-order lines presented few complications. The longest wave-length appearing in the 1925 spectra is λ 3545.20 of the second order, equivalent to λ 7090.40 of the first order.

The definition of the 1905 spectra is superior to that shown by the 1925 photographs. The main cause of the difference is due to the "seeing," which was excellent in 1905 and poor in 1925. In slitless spectra, the character of the seeing has a very important bearing on the quality of the spectra. It makes all the difference in the world whether the spectral lines are sharp and clean cut and well defined, or whether their edges are weak and ill defined from atmospheric disturbances. In *Handbuch der Astrophysik*, **4**, 275, 1929, the writer has ventured the opinion that "it is more difficult to secure a perfectly successful photograph of the flash spectrum than it is to obtain an excellent photograph of any other single phenomenon attacked by astrophysical science.".

For purposes of comparison, there are given in Plates I and II portions in the neighborhood of the H and K lines of the spectra of the 1905 and 1925 eclipses. It will be seen that though the latter spectrum shows good definition, it has not the fine qualities of the earlier eclipse. Hence, in combining the measures of the 1905 and 1925 eclipses, greater weight was given to the 1905 results. The writer regards himself as very fortunate in having had in 1905, more or less the result of a happy accident, such fine qualities of seeing.

NUMBER OF LINES IN THE FLASH SPECTRUM

The total number of lines in the flash spectrum included in Table V is 3250. In Tables I and II these are arranged according to elements; in Table I appear the neutral lines and in Table II those coming from enhanced or ionized elements. In these two tables the lines are arranged according to the first of the elements identified for each line in Table V, the first element in each case being regarded as the most important element in the formation of the line in the flash spectrum. In Table III the lines in the flash are arranged according to their intensities in the flash, where 200 represents the maximum intensity and 0 that of a line just visible.

References to Tables I and II show that neutral iron is responsible for more than one-third of the total number of lines (37.6 per cent) of the flash spectrum. Next in order of total numbers comes enhanced titanium (Ti^+) with 226 lines, and then neutral *Ti* with 195 lines. The element titanium is responsible for 421 lines, or 13.0 per cent of the total. A total of 240 lines comes from chromium, neutral and enhanced combined, or 7.4 per cent. Next in order is *Ni* with a total of 185 lines, or 5.7 per cent. Only three lines come from Ni^+. Carbon in various compounds produces a total of 140 lines. Vanadium is the cause of 130 lines; neutral *V* has 2.3 per cent and V^+ 1.7 per cent of the total. Zirconium is responsible for a total of 106 lines, or 3.3 per cent, most of the lines being enhanced. Manganese produces 92 lines; *Co* gives 84 lines, none of which is enhanced. The other elements arranged according to totals are *Sc* (62 lines), *Ca* (59), *Ce* (57 lines all enhanced). *Y* (55), La^+ (47), *H* (33), Nd^+ (31). Helium shows a total of nineteen lines of which number one only (λ 4686) is enhanced. As is well known, no *He* lines appear in the ordinary solar spectrum. Magnesium has a total of sixteen lines in the flash spectrum, with only one line (λ 4481) due to Mg^+.

Of the total of 3250 lines of the flash spectrum, 73, or 1 out of every 45 lines, cannot yet be identified. Of this number there are only 15 single lines (not blends) of Rowland intensity 2 or greater whose sources cannot be identified. These lines are given in Table IV. The wave-lengths given are from the *Revised Rowland*. A comparison of intensities in sun, in flash, and in α Persei shows that all of the lines in Table IV probably belong to elements in neutral states except λ 5991.38, which appears to be an enhanced line.

TABLE I

Numbers of Lines of Neutral Elements and Carbon Compounds

Region	Elements																				Totals	Compounds			Totals	Un-known
	Fe	*Ti*	*Ni*	*Cr*	*Co*	*Mn*	*V*	*Ca*	*H*	*He*	*Zr*	*Mg*	*Sc*	*Si*	*Y*	*Na*	*Cu*	*Zn*	*Al*	*Sr*		*CN*	C_2	*CH*		
3066–3099	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3100–3199	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...
3200–3299	14	2	3	...	...	1	...	1	...	...	...	...	...	...	...	...	2	...	...	...	23	...	...	...	...	...
3300–3399	17	4	5	...	3	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	31	...	...	...	...	...
3400–3499	34	2	13	3	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	60	...	...	...	...	3
3500–3599	50	1	12	2	17	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	87	1	...	...	1	...
3600–3699	59	5	7	6	4	1	1	2	19	1	...	...	...	...	...	...	...	...	...	...	105	...	...	...	...	...
3700–3799	51	8	6	4	3	...	1	...	7	1	2	...	...	...	...	...	...	...	...	...	83	4	...	...	4	...
3800–3899	53	2	1	5	7	5	6	...	2	1	1	3	...	...	...	...	...	...	...	...	86	44	...	...	44	...
3900–3999	59	7	3	6	7	4	4	1	1	1	...	2	2	1	...	...	...	...	2	...	100	...	...	...	...	...
4000–4099	65	11	...	1	7	19	2	2	...	2	3	1	4	...	2	...	...	...	...	...	119	...	...	...	...	2
4100–4199	69	4	...	4	2	3	8	1	1	3	1	1	...	1	1	...	...	...	...	...	99	7	...	...	7	2
4200–4299	65	12	2	9	...	4	2	3	...	...	2	...	...	...	1	...	...	...	...	...	100	...	...	15	15	...
4300–4399	28	6	4	7	...	1	5	3	1	1	...	...	...	...	...	...	...	...	...	...	56	...	...	14	14	2
4400–4499	39	18	5	7	1	9	12	6	...	2	...	...	...	...	1	...	...	...	...	...	100	...	...	...	...	3
4500–4599	30	16	3	12	3	2	9	4	...	...	1	1	...	...	...	...	...	...	...	...	81	...	...	...	...	3
4600–4699	32	9	4	28	...	1	1	1	...	...	2	...	...	...	...	...	...	1	...	1	80	...	...	...	...	9
4700–4799	45	8	10	8	2	8	2	...	...	1	1	1	...	...	...	...	...	1	...	...	87	...	...	...	...	5
4800–4899	37	7	10	3	2	1	7	...	1	...	1	...	...	...	...	...	...	1	...	...	70	...	...	...	...	2
4900–4999	51	9	18	4	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	83	...	...	...	...	1
5000–5099	45	21	19	2	...	...	...	...	...	1	...	...	2	...	...	...	...	...	...	...	90	...	11	...	11	2
5100–5199	40	8	11	6	...	1	...	...	...	...	1	2	1	...	...	...	...	...	...	...	70	...	35	...	35	3
5200–5299	35	5	2	16	4	...	...	2	...	...	...	...	...	...	...	...	1	...	...	...	65	...	...	...	...	1
5300–5399	37	1	1	8	6	3	1	1	...	...	...	...	1	...	...	...	...	...	...	...	59	...	...	...	...	3
5400–5499	40	6	6	1	4	4	1	...	...	...	...	...	1	...	...	...	...	...	...	...	63	...	...	...	...	10
5500–5599	34	5	5	...	3	4	...	6	...	...	...	1	1	...	2	...	...	...	...	1	62	...	2	...	2	6
5600–5699	30	4	7	3	1	...	3	1	...	...	...	...	1	4	...	2	...	...	...	...	56	...	7	...	7	5
5700–5799	26	1	5	6	...	...	2	...	...	...	...	1	1	4	...	...	...	...	...	...	46	...	...	...	...	3
5800–6099	51	9	5	...	...	3	3	2	...	...	1	...	...	1	...	2	...	...	...	...	77	...	...	...	...	1
6100–6399	49	4	11	1	...	...	4	8	...	...	...	...	...	...	...	2	...	...	...	...	79	...	...	...	...	7
6400–7065	37	...	3	...	...	...	...	8	1	2	...	...	...	...	...	...	...	...	...	...	51	...	...	...	...	...
Totals	1222	195	182	152	84	79	74	52	33	18	16	15	14	11	7	6	3	3	2	2	2170	56	55	29	140	73

TABLE II

Numbers of Lines of Various Ionized Elements

Region	Elements																								Totals
	Ti^+	Fe^+	Zr^+	Cr^+	Ce^+	V^+	Sc^+	Y^+	La^+	Nd^+	Sa^+	Mn^+	Ba^+	Gd^+	Ca^+	Pr^+	Dy^+	Eu^+	Si^+	Sr^+	Ni^+	Be^+	He^+	Mg^+	
3066–3099	6	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
3100–3199	18	12	6	10	1	9	.....	1	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	1	.....	.....	61
3200–3299	37	14	7	5	.....	8	.....	3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	75
3300–3399	31	4	12	19	.....	.....	4	1	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	75
3400–3499	14	1	11	7	.....	2	.....	1	.....	.....	.....	10	.....	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	48
3500–3599	11	.....	7	1	.....	10	7	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	39
3600–3699	6	.....	7	2	.....	.....	6	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26
3700–3799	8	.....	5	2	1	6	.....	5	3	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	32
3800–3899	3	.....	4	.....	3	2	.....	1	.....	1	.....	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	16
3900–3999	3	1	4	.....	3	5	1	2	4	4	.....	.....	.....	1	2	.....	.....	2	.....	.....	.....	.....	.....	.....	32
4000–4099	5	.....	4	1	6	5	1	.....	4	2	.....	.....	.....	2	.....	.....	.....	.....	.....	1	1	.....	.....	.....	32
4100–4199	6	3	4	2	9	3	.....	2	4	2	2	.....	2	.....	.....	1	2	1	.....	.....	.....	.....	.....	.....	43
4200–4299	3	4	3	3	4	3	3	1	5	.....	2	3	.....	1	.....	1	1	.....	.....	1	.....	.....	.....	.....	38
4300–4399	18	4	4	.....	4	.....	5	4	5	5	3	.....	.....	1	.....	1	.....	.....	.....	1	.....	.....	.....	.....	55
4400–4499	14	4	9	.....	6	.....	4	1	2	3	5	.....	.....	2	.....	2	1	.....	.....	.....	.....	.....	.....	1	54
4500–4599	13	9	.....	5	4	1	.....	.....	2	1	5	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	42
4600–4699	2	5	1	4	3	1	1	1	3	.....	3	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	26
4700–4799	7	1	.....	1	2	.....	.....	1	3	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
4800–4899	3	.....	.....	7	1	.....	.....	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
4900–4999	1	1	.....	.....	.....	.....	.....	1	3	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
5000–5099	3	1	.....	.....	2	.....	1	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	10
5100–5199	4	2	1	1	.....	.....	.....	3	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
5200–5299	4	5	.....	6	1	.....	1	3	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
5300–5399	3	5	1	5	2	.....	2	.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
5400–5499	2	2	.....	4	2	.....	.....	4	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
5500–5599	.....	1	.....	3	.....	.....	2	2	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
5600–5699	.....	.....	.....	.....	2	.....	6	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
5700–5799	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
5800–6099	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
6100–6399	.....	7	.....	.....	1	.....	3	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	14
6400–7065	1	5	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
Totals	226	91	90	88	57	56	48	48	47	31	22	13	8	8	7	5	4	4	4	4	3	1	1	1	867

TABLE III

NUMBERS OF LINES ARRANGED ACCORDING TO THEIR INTENSITIES IN THE FLASH SPECTRUM

Region	Intensity																											Totals
	0	1	2	3	4	5	6	7	8	9	10	12	15	18	20	25	30	35	40–45	50–55	60	70	80	90–100	120–140	160–175	200	
3066–3099	....	1	....	2	....	2	....	....	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7
3100–3199	1	14	12	9	4	4	2	5	3	....	4	3	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	63
3200–3299	1	14	19	18	8	5	5	6	6	3	5	4	....	....	2	1	1	....	....	....	....	....	....	....	....	....	....	98
3300–3399	....	13	30	12	13	3	6	4	5	1	2	3	4	3	2	3	1	1	....	....	....	....	....	....	....	....	....	106
3400–3499	....	7	29	17	14	12	8	3	2	....	5	7	4	2	1	....	....	....	....	....	....	....	....	....	....	....	....	111
3500–3599	....	6	37	33	10	11	1	6	4	....	7	6	2	2	2	....	....	....	....	....	....	....	....	....	....	....	....	127
3600–3699	....	10	35	25	16	6	3	2	4	....	2	11	4	4	2	3	1	1	1	....	....	....	1	....	....	....	....	131
3700–3799	....	2	25	14	24	12	8	4	5	....	5	....	2	1	4	1	1	1	2	2	....	4	1	1	....	....	....	119
3800–3899	....	1	30	26	24	20	11	2	9	....	8	....	4	....	4	1	....	1	1	1	1	....	....	1	1	....	....	146
3900–3999	....	5	25	25	24	9	13	....	9	....	8	2	1	....	4	1	....	1	2	....	....	....	....	....	1	1	1	132
4000–4099	....	19	28	35	21	10	12	3	6	....	2	2	2	1	3	....	2	....	....	....	....	....	1	....	....	....	....	153
4100–4199	1	23	38	22	29	12	9	3	2	1	3	1	5	....	1	....	....	....	....	....	....	....	....	....	1	....	....	151
4200–4299	5	26	41	32	15	7	8	1	2	2	4	....	1	3	1	1	1	....	1	1	1	....	....	....	....	....	....	153
4300–4399	5	28	33	15	15	5	6	1	3	....	3	3	5	....	....	3	....	....	1	....	....	....	....	....	....	1	....	127
4400–4499	24	40	35	18	15	7	2	4	5	2	....	2	....	....	....	....	1	....	1	....	....	....	1	....	....	....	....	157
4500–4599	23	23	31	12	14	2	4	....	3	....	2	2	1	1	1	2	2	1	....	2	....	....	....	....	....	....	....	126
4600–4699	20	24	31	17	9	5	4	1	3	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	115
4700–4799	13	33	28	15	10	3	3	1	2	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	110
4800–4899	14	21	23	10	1	5	2	1	3	....	2	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	1	86
4900–4999	19	23	26	13	3	1	2	....	1	....	1	....	....	1	....	1	1	....	....	....	....	....	....	....	....	....	....	92
5000–5099	26	31	41	7	3	2	....	1	1	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	113
5100–5199	15	55	20	14	6	2	2	2	....	....	....	2	....	1	....	1	1	....	1	....	....	....	....	....	....	....	....	122
5200–5299	19	18	20	7	5	5	2	3	3	....	2	1	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	87
5300–5399	20	17	14	9	6	2	4	3	5	....	....	1	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	83
5400–5499	28	21	12	10	2	6	3	1	2	....	2	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	90
5500–5599	24	10	17	5	8	1	3	5	4	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	79
5600–5699	25	23	7	8	5	6	1	....	1	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	78
5700–5799	10	13	10	5	4	6	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	50
5800–6099	14	9	13	16	8	4	5	4	1	....	1	1	....	....	1	1	....	....	....	....	....	....	1	....	....	....	....	79
6100–6399	15	7	23	13	12	9	3	7	4	....	5	....	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	100
6400–7065	5	7	16	7	7	2	2	3	....	2	2	1	2	....	2	....	....	....	....	....	....	....	....	....	....	....	1	59
Totals	327	544	749	471	335	192	136	76	99	11	79	56	46	19	34	21	12	6	10	6	2	4	5	2	3	2	3	3250

Great care was exercised to be sure that no lines were included in the tabular material of the flash spectrum for the existence of which there was any doubt. In reaching the low levels shown by the flash spectra discussed in this publication, the emission lines are seen superposed on a strong continuous spectrum. In measuring the weakest lines of the flash it was necessary to study the spectrum closely and then come to a decision regarding the lines. The weak, low-lying lines are short in length and with little increase in intensity over the continuous spectrum. Naturally it was difficult to decide from the original negative whether the line was real or whether it was

TABLE IV

UNIDENTIFIED LINES IN CHROMOSPHERE, OF ROWLAND INTENSITIES 2 OR GREATER

Wave-Length	Intensities			Wave-Length	Intensities		
	Sun	Flash	α Persei		Sun	Flash	α Persei
3416.03	3	3	....	4730.04	2	2	*b*
3425.58	2	2	....	4748.14	4	3	3
4037.12	2	0	....	5991.38	2	7	*b*
4159.19	5	2	*b*	6145.03	2	2	0
4188.74	4	2	4	6155.15	7	3	*b*
4605.60	2	0	2	6237.33	3	2	....
4672.34	3	1	2	6244.48	2	1	1
4699.34	4	2	3				

The first three lines of the foregoing table are not included in the region of the Mount Wilson spectra discussed by Dunham. The symbol *b* in the fourth column signifies that the line is a blend in α Persei.

merely the accidental lining-up of silver grains into something that looked exactly like a line. As the 1905 spectra were independently measured three (or more) times, separated by long intervals, lines not having a real existence generally disappeared in taking the means of the measures. These decisions were put into practice before the earlier publication in the year 1913. In the present revision many of the weaker lines of the earlier publication are omitted. These weak lines probably have little importance in deciding on the real meaning of the flash spectrum. It seemed well to err on the side of including too few rather than too many lines. A reference to Table V will show that in the 1000 A at the violet end of the flash spectrum there are only three lines of the tabular values which have not been identified.

TABLE V

Explanation of table.—Wave-lengths are in international angstroms. The "Elements" in the third column are arranged in order of their importance in the chromosphere, the most important being placed first. Owing to limitations of space in printing, the less important elements were frequently omitted. The intensities in the fourth column are from the *Revised Rowland;* the designation 5^3 means that three lines are blended, the sum of the individual intensities being 5. Flash intensities are approximately on the same scale as the *Revised Rowland.* Heights are given in kilometers. Excitation potentials are assigned for the first element only. If the E.P. is unknown for the first element, but is known for the second element, the designation $(^2)$ is then used in the last column.

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3066.32	.36	Ti^+	5^3	3	1000	0.00
3072.21	.12	Ti^+	3	3	1000	.03
3072.97	.98	Ti^+	6	5	1000	.00
3075.24	.24	Ti^+	3	5	1000	.01
3078.64	.66	Ti^+	8	8	1500	.03
3088.02	.04	Ti^+	7	12	2000	.05
3092.88	.87	$V^+\text{-}Al\text{-}$	8^4	1	.....	.39
3102.24	.30	V^+	3	3	.....	0.37
3106.23	.24	Ti^+	3	2	.....	1.24
3110.71	.70	$Ti^+\text{-}V^+$	5	4	.....	1.23
3117.75	.78	$Ti^+\text{-}Ti$	5^3	1	.....	1.23
3118.41	.39	V^+	3	2	.....	0.33
3118.62	.66	Cr^+	2	12	1500	2.41
3119.74	.80	Ti^+	1	2	.....	1.24
3120.36	.37	Cr^+	3	10	1500	2.42
3121.02	.16	V^+	4	1	.....	0.39
3125.00	.00	$Cr^+\text{-}$	4	15	1500	2.44
3125.34	.29	V^+	5	1	.....	0.32
3126.20	.17	$V^+\text{-}Zr^+\text{-}*$	6^2	2	.....	0.37
3128.68	.71	Cr^+	2	6	1500	2.42
3129.12	.18	Zr^+	0	1	.....	0.52
3129.74	.77	Zr^+	0	2	.....	.04
3130.40	.31	$V^+\text{-}Be^+$	4^2	3	.....	.35
3130.76	.80	$Ti^+\text{-}Ti$	3	4	.....	.01
3131.13	.06	Be^+	1	1	.....	0.00
3132.05	.06	Cr^+	4	20	1500	2.47
3133.38	.38	$V^+\text{-}Zr^+$	3^2	1	.....	0.33
3134.17	.12	$Ni\text{-}Fe$	8	0	.....	0.21
3135.01	.94	V^+	2	1	.....	2.51
3135.42	.41	$Fe^+\text{-}Fe$	2^2	1	.....	.....
3136.67	.71	$Cr^+\text{-}Co$	3	5	1000	2.44
3138.66	.68	Zr^+	1	2	.....	0.09
3143.75	.76	Ti^+	4	3	1000	0.03
3147.22	.24	Cr^+	3	4	1000	2.47
3148.04	.04	Ti^+	2	5	1000	0.00
3149.96	.92	$Cr^+\text{-}$	4^3	1	.....	.....
3152.24	.26	Ti^+	5	3	1000	.12
3154.19	.20	$Ti^+\text{-}Fe^+$	3	5	1000	.11
3155.63	.66	Ti^+	3	2	.....	.13
3157.51	.46	$Ti^+\text{-}$	2^2	1	.....	0.01
3158.89	.89	Ca^+	2	6	.....	3.11
3161.19	.20	Ti^+	3	7	1000	0.11
3161.80	.78	Ti^+	3	8	1000	.12
3162.56	.57	Ti^+	4	10	1000	0.13
3163.11	.14	Fe^+	2^2	2	.....	1.66
3165.98	.96	$Zr^+\text{-}$	2	2	.....	0.16
3166.40	.34	$Zr^+\text{-}Fe$	3^3	1	.....	.80
3167.84	.88	$Fe^+\text{-}Fe$	5^2	3	.....	.....
3168.49	.53	Ti^+	4	12	1000	0.15
3170.31	.34	$Fe^+\text{-}Mo$	2	3	.....	1.69
3177.56	.54	$Fe^+\text{-}$	2	1	.....	.....
3179.33	.34	Ca^+	5	8	1000	3.14
3180.67	.73	$Cr^+\text{-}Cr\text{-}*$	4^2	10	1000	2.53
3181.30	.28	$Ca^+\text{-}Cr^+$	4^2	4	.....	3.14
3183.11	.12	Fe^+	2	5	1000	1.69
3184.08	.03	$Ti^+\text{-}V$	3^2	2	.....	0.01
3185.26	.33	Fe^+	2	3	.....	1.72
3186.01	.04	$Ce^+\text{-}Co$	1^2	1	.....	1.87^2
3186.72	.75	Fe^+	3	7	1000	1.69
3187.37	.31	Fe^+	1	2	.....	.....
3187.71	.71	$He\text{-}V^+$	2	10	1200	19.73
3188.45	.54	$V^+\text{-}Fe$	6	3	.....	1.09
3190.82	.82	$Ti^+\text{-}V^+\text{-}*$	7^3	12	1200	1.08
3191.91	.99	$Zr^+\text{-}Ti$	2^2	2	.....	0.80
3192.88	.86	$Fe^+\text{-}Fe$	3^2	7	1000	1.66
3193.79	.82	Fe^+	1	7	1000	1.72
3195.71	.64	$Y^+\text{-}Ti^+$	3^2	2	.....	0.10
3196.04	.11	Fe^+	3	7	1000	1.66
3197.01	.03	$Cr^+\text{-}Fe$	6^3	8	1000	0.21
3197.51	.54	$Ti^+\text{-}Fe$	1	1	.....	.03
3200.23	.31	$Y^+\text{-}Fe\text{-}\dagger$	9^3	2	.....	0.13
3202.50	.54	$Ti^+\text{-}Fe$	2	10	1000	1.08
3203.32	.40	$Y^+\text{-}Ti^+$	3^2	4	.....	0.10
3208.47	.48	$Cr^+\text{-}V^+\text{-}*$	3^3	2d	.....	2.53
3209.17	.19	Cr^+	1	7	1000	2.53
3210.49	.45	Fe^+	2	8	1000	1.72
3211.98	.02	Fe	4^3	1	.....	2.39
3213.27	.27	$Fe^+\text{-}Ti^+\text{-}\dagger$	4^2	12	1000	1.69
3214.12	.17	$Zr^+\text{-}Fe\text{-}\dagger$	7^4	3	.....	0.09
3214.78	.78	$Ti^+\text{-}V^+$	3	5	1000	0.05
3215.34	.31	$Ca\text{-}V$	3^3	0	.....	1.88
3215.89	.91	$Fe\text{-}$	3^2	1	.....	2.46
3216.70	.70	Y^+	1	4	.....	0.13
3217.10	.08	$Ti^+\text{-}V^+$	3^2	9	1500	0.03
3217.40	.39	$Cr^+\text{-}Fe$	2	8	.....	2.53
3218.25	.28	Ti^+	2	5	1000	1.56
3219.77	.72	$Fe\text{-}Cr$	5^2	1	.....	2.47
3222.00	.07	Fe	4^2	1	.....	2.47

* *Fe.* † *Ti.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km.	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km.	E.P.
3222.89	.86	Ti^+	4	10	1500	0.01	3272.17	.14	Ti^+-Zr^+	7^2	6	1500	1.22
3223.51	.52	Ti	0	1	.....	2.01	3273.03	.05	Zr^+	2	4	1000	0.16
3224.26	.25	Ti^+	2	5	1000	1.58	3274.00	.97	Cu	10	3	.....	0.00
3225.77	.80	Fe	3	2	.....	2.39	3275.29	.30	Ti^+	3	2	.....	1.08
3226.79	.76	Ti^+-Fe	3^2	3	1000	0.03	3276.12	.14	V^+	5	7	1200	1.12
3227.74	.78	Fe^+-Fe	4^2	12	1000	1.66	3276.82	.87	Ti^+	5^2	4	800	1.18
3228.59	.62	Ti^+	2	7	1000	1.08	3277.36	.36	Fe^+-Co	7	12	1200	0.98
3229.23	.18	Ti^+-Fe	5^2	9	1500	0.00	3278.26	.30	Ti^+	5	6	1200	1.23
3229.43	.43	Ti^+	2	5	.....	1.13	3278.90	.94	Ti^+	4	8	1000	1.08
3231.32	.33	Ti^+	2	4	.....	0.13	3279.31	.28	Zr^+	2	3	800	0.09
3231.80	.83	Zr^+-V^+	2^2	2	.....	0.04	3279.93	.95	Ti^+-V^+	3^2	3	800	1.11
3232.29	.29	Ti^+	2	6	1000	1.11	3281.32	.30	Fe^+	5	7	1200	1.04
3232.82	.89	Ni-Ti-*	3^2	2	.....	0.00	3282.33	.34	Ti^+	5	6	1200	1.22
3234.49	.52	Ti^+	3	30	2000	0.05	3282.86	.82	Ni-Fe	6^3	2	800	0.16
3236.15	.14	Ti^+	1	4	1000	1.08	3284.70	.72	Zr^+	1	3	800	0.[illegible]
3236.59	.59	Ti^+	7	25	2000	0.03	3285.41	.42	Fe^+	2	3	1200	1.07
3237.90	.85	V^+	2	3	1000	2.03	3286.78	.77	Fe	7	2	800	2.17
3239.03	.05	Ti^+	7	20	2000	0.01	3287.65	.67	Ti^+-Fe	5	10	1000	1.88
3239.69	.67	Ti^+	2	8	1000	1.08	3288.18	.16	Ti^+	3	3	800	0.13
3241.12	.05	Zr^+	1	2	.....	0.04	3288.60	.57	Ti^+-Zr^+-*	6^4	4	800	1.23
3242.00	.01	Ti^+	8	20	2000	.00	3289.34	.40	V^+-Fe	7^2	3	800	1.09
3243.06	.07	Ni	6	2	.....	0.02	3290.88	.91	Fe	6^2	1	600	2.21
3243.74	.77	Fe^+-Mn	2	3	1000	2.15^2	3292.05	.02	Fe-Cr^+-†	8^3	3	600	.....
3245.10	.14	La^+	−1	2	.....	0.17	3295.49	.44	Cr^+	2	3	800	2.53
3246.05	.01	Fe	7^2	2	.....	0.11	3295.83	.82	Fe^+-Mn	6	8	1200	1.07
3247.22	.25	Fe^+-Fe	4^2	1	.....	1.95^2	3298.73	.72	V^+-Co	5^2	1	800	1.12
3247.56	.57	Cu	10	3	.....	0.00	3299.41	.44	Ti	2	1	400	0.90
3248.64	.61	Ti^+	1	7	1500	1.24	3302.14	.11	Ti^+	4	2	600	0.15
3249.40	.38	Ti^+-La^+	2	2	.....	1.08	3302.81	.86	Fe^+	8^2	6	1200	1.04
3251.21	.26	Fe	3	1	.....	2.19	3303.51	.52	Fe^+-Fe	5^2	5	800	1.09
3251.96	.90	Ti^+	7^2	10	1500	0.01	3305.14	.16	Zr^+-Fe	2	2	600	0.04
3252.94	.93	Ti^+-Mn-*	9^2	12	1500	.03	3306.04	.98	Fe-	8^3	1	500	2.19
3254.24	.28	Ti^+-Fe	11^3	9	1500	0.05	3306.31	.35	Zr^+-Fe	6^2	4	800	0.04
3254.72	.76	V^+-V-*	5	2	.....	2.02	3307.08	.05	Cr^+-La^+-*	4^3	3	600	2.53
3255.88	.90	Fe^+	6	8	1500	0.98	3307.74	.72	Fe-Ti^+	4	2	500	0.12^2
3256.46	.50	Zr^+-	1	2	.....	0.71	3308.80	.80	Ti^+-Mn	7^2	6	1000	0.13
3256.89	.91	Fe	4^2	1	.....	.....	3309.54	.53	Ti-	2	1	500	1.05
3257.41	.42	Fe-	10^3	1	.....	2.17	3310.55	.45	Fe-	6^3	1	500	.....
3257.91	.91	V^+	0	2	.....	.....	3311.87	.94	Cr^+-Mn	2	2	600	2.53
3258.34	.42	Mn	3	1	.....	.....	3312.21	.20	Co-Fe	3	1	500	.....
3258.73	.78	Fe^+	3	3	1000	.....	3312.75	.70	Fe^+-Ti	2	4	800	1.07
3259.06	.06	Fe^+	3	3	1000	.....	3313.97	.00	Fe^+	1	4	800	1.09
3260.25	.27	Ti^+-Mn-*	5	2	.....	1.16	3314.54	.48	Ti-Mn	5^2	1	500	1.05
3261.57	.61	Ti^+	7^2	10	1500	1.23	3315.32	.33	Ti^+	3	6	1000	1.22
3262.37	.29	Fe	3	2	.....	.....	3317.30	.22	Fe-Mn	4^3	2d	500	2.27
3263.58	.53	Ti^+-Fe	8^2	3d	1000	1.16	3318.03	.03	Ti^+	6	7	1000	0.12
3264.76	.75	Fe^+-Zr^+	11^4	4	1000	0.93	3319.09	.16	Fe-Ti^+	6^3	2	600	$.13^2$
3265.64	.61	Fe-La^+	6^2	2	.....	2.17	3320.29	.26	Ni	7	2	600	0.16
3266.95	.92	Fe^+	1	1	.....	.....	3321.71	.71	Ti^+	4	9	1200	1.23
3267.71	.71	V^+	6	6	1200	1.07	3322.29	.32	Ni	3	2	500	0.42
3270.15	.14	Cr^+-Co	1	3	.....	.....	3322.91	.95	Ti^+	8^2	20	1500	0.15
3271.11	.07	V^+-Zr^+-*	11^2	7	1200	1.09	3323.75	.75	Fe	3	2	500	.....
3271.62	.67	Ti^+-Fe	6	5	1200	1.24	3324.06	.07	Cr^+	4	4	800	2.42

* *Fe.* † *Ti.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3325.50	.48	Fe	3	1	500	2.44	3372.84	.81	Ti^{+}	10^{2}	30	2500	0.01
3326.75	.78	Ti^{+}	5	8	1000	0.11	3374.32	.27	Ti^{+}-Ni	6^{2}	5	800	1.23
3327.87	.89	Y^{+}	2	3	800	0.41	3374.64	.67	Zr^{+}-Ni	3^{2}	4	600	1.00
3328.40	.36	Cr^{+}	2	3	800	2.41	3376.40	.42	La^{+}-Fe	4^{2}	2d	400	0.32
3328.88	.87	Fe	3	2	500	......	3377.56	.54	Ti	6^{2}	2	400	0.02
3329.42	.44	Ti^{+}-Co	8^{2}	18	1500	0.13	3378.34	.34	Cr^{+}-Zr^{+}	2	4	800	3.09
3329.99	.94	Mg-Fe	5^{2}	2	500	2.70	3379.35	.38	Cr^{+}-Sc^{+}	2	4	800	3.09
3331.73	.70	Fe	4^{2}	2	500	2.42	3379.87	.85	Cr^{+}-Ti^{+}	4^{2}	5	800	3.09
3332.08	.11	Ti^{+}	3	12	1200	1.24	3380.25	.23	Ti^{+}-Fe	9^{3}	15	1500	0.05
3334.17	.17	Zr^{+}-Co*	6^{3}	2d	500	0.43^{2}	3380.70	.72	La^{+}-Sr^{+}-	12^{3}	1	600	0.32
3335.18	.19	Ti^{+}	6^{2}	15	1500	0.12	3382.72	.69	Cr^{+}	4	12	1500	2.44
3336.30	.30	Cr^{+}-Fe	4^{2}	6	1000	2.41	3383.84	.84	Ti^{+}-Fe	9^{3}	25	2500	0.00
3336.66	.69	Mg-	8	2	500	2.70	3385.08	.07	Co-	5^{3}	3	500	.51
3336.90	.95	Ti^{+}-	2^{3}	1	600	1.18	3387.40	.42	Fe	2	1	400	......
3337.38	.35	La^{+}-Co	2^{2}	2	600	0.40	3387.88	.85	Ti^{+}-Zr^{+}	5	18	1500	0.03
3337.87	.85	Ti^{+}	3^{2}	2	800	1.23	3388.80	.76	Ti^{+}	2	4	800	1.23
3339.16	.14	Fe-Ni	3^{2}	1	500	2.44	3391.05	.05	Ni-Cr	6^{2}	2	400	0.00
3339.79	.80	Cr^{+}-Co	3	7	1000	2.42	3391.42	.44	Cr^{+}	2	3	800	2.41
3340.33	.35	Ti^{+}	5^{2}	15	1500	0.11	3391.96	.97	Zr^{+}	2	8	800	0.16
3341.88	.88	Ti^{+}-Fe	8^{2}	25	2000	0.57	3392.60	.64	Fe-Ti	3^{2}	1	400	2.17
3342.61	.59	Cr^{+}	3	7	1000	2.44	3393.14	.09	Cr^{+}-Zr^{+}	2^{2}	8	800	3.09
3343.74	.78	Ti^{+}-Fe	4	8	1000	0.15	3393.80	.85	Cr^{+}	2	4	800	3.09
3344.50	.52	La^{+}-Ca	2	3	600	.23	3394.56	.58	Ti^{+}-Fe	6^{2}	15	1500	0.01
3344.82	.79	Zr^{+}	0	2	600	......	3395.37	.39	Co	5^{2}	1	400	.58
3346.73	.75	Ti^{+}-Cr	5^{2}	10	1000	0.13	3396.37	.35	Zr^{+}-Fe	1^{2}	3	600	$.95^{2}$
3347.89	.89	Cr^{+}-Fe	6^{2}	7	1000	2.42	3397.00	.98	Fe	3	2	400	.95
3349.00	.98	Ti^{+}-Cr	9^{3}	20	1500	0.12	3399.30	.31	Zr^{+}-Fe	5^{2}	4	800	.32
3349.41	.45	Ti^{+}	9^{2}	35	2500	0.05	3401.51	.53	Fe	3	2	400	0.91
3350.46	.48	Ti^{+}-Ni^{+}	3^{2}	2	600	1.16	3402.43	.42	Ti^{+}-Cr^{+}	3	8	1200	1.22
3352.11	.07	Ti^{+}	2	3	800	1.22	3403.35	.35	Cr^{+}-Ni-*	6^{3}	12	1500	2.42
3353.11	.11	Fe-Cr^{+}-†	4^{3}	2	500	2.42	3404.35	.34	Fe	5^{2}	3	500	2.19
3353.74	.74	Sc^{+}	4	8	1000	0.31	3404.80	.79	Zr^{+}-Fe	2^{2}	4	800	0.36
3354.35	.39	Zr^{+}-Co	3	2	500	.75	3406.78	.81	Fe	5	2	500	2.21
3354.66	.65	Ti	3	1	400	.02	3407.21	.26	Ti^{+}-Ni^{+}	4^{2}	5	800	0.05
3355.22	.23	Fe	4	2	400	......	3407.52	.51	Fe	7^{2}	2	600	2.17
3356.11	.10	Zr^{+}	1	3	500	.09	3408.81	.78	Cr^{+}	3	15	1500	2.47
3357.37	.32	Zr^{+}-	3^{2}	4	600	0.00	3409.79	.82	Ti^{+}	2	5	800	0.03
3358.50	.52	Cr^{+}	4	12	1200	2.44	3410.22	.21	Zr^{+}-Fe	3^{2}	4	800	.41
3359.72	.69	Sc^{+}	2	2	600	0.01	3411.33	.37	Fe	3	2	400	......
3360.05	.02	Zr^{+}-	3^{2}	2	500	1.48	3412.46	.48	Co	9^{2}	1	400	0.00
3360.35	.31	Cr^{+}	2	10	1000	3.09	3413.14	.14	Fe	5	2	500	2.19
3361.24	.23	Ti^{+}-Sc^{+}	5^{2}	25	2500	0.02	3413.51	.49	Ni-	4^{2}	1	400	0.16
3361.98	.02	Sc^{+}-Ca	3^{2}	3	600	0.00	3413.99	.95	Ni	4	2	400	.11
3362.69	.65	Ti^{+}-	1	2	500	1.22	3414.78	.78	Ni	15	7	1000	0.02
3363.75	.70	Cr^{+}-Ni	3^{3}	3	800	2.42	3416.03	.03	....	3	3	600	......
3366.21	.18	Ti^{+}-Ni-†	6	4	600	1.23	3416.99	.96	Ti^{+}	1	3	800	1.23
3366.82	.84	Fe-Ni	6^{2}	4	500	2.19	3418.48	.52	Fe	5	2	600	2.21
3368.07	.06	Cr^{+}	5	18	1500	2.47	3421.25	.22	Cr^{+}	4	12	1500	2.41
3368.92	.95	Sc^{+}	3	6	800	0.01	3422.71	.72	Cr^{+}-Fe	7^{2}	15	1500	2.44
3369.63	.58	Ni	6	3	500	.00	3423.71	.72	Ni	7	3	500	0.21
3370.82	.80	Fe	4	2	400	......	3424.27	.30	Fe	4	2	500	2.17
3371.76	.76	Ni-Ti	7^{2}	2d	400	.16	3425.00	.02	Fe	4	2	500	......
3372.21	.22	Ti^{+}-Sc^{+}	3^{2}	6	800	0.60	3425.56	.58	....	2	2	500	......

* *Fe.* † *Ti.*

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3426.32	.37	Fe	6^2	3	600	0.99	3475.15	.13	Cr^+	2	6	800	2.42
3426.70	.66	Fe	5^2	3	600	2.19	3475.44	.46	Fe	10	6	800	0.09
3427.12	.10	Fe	6^3	4	600	2.17	3476.68	.71	Fe	8	4	800	.12
3428.18	.21	Fe-Co	4	3	500	2.19	3477.17	.19	Ti^+	5	12	1200	.12
3430.57	.54	Zr^+	1	5	1000	0.46	3478.60	.55	Fe-Zr^+	3^5	4d	500	$.09^2$
3431.59	.59	Co	4	2	500	.10	3479.40	.39	Zr^+	2	6	800	.71
3432.43	.42	Zr^+	−1	1	500	0.93	3480.39	.40	Zr^+-Ti-*	3^3	2	600	0.93
3433.34	.32	Cr^+	3	18	1500	2.42	3480.90	.89	Ti^+	2	3	600	1.08
3436.00	.05	Cr-Fe	4^4	2d	400	2.53	3481.20	.16	Zr^+	2	6	800	0.80
3437.19	.20	Ni-Fe-	8^3	4d	600	0.00	3482.95	.91	Mn^+	5	15	1500	1.82
3438.22	.24	Zr^+	2	7	800	0.09	3483.65	.64	Ni-Co	9^3	4	500	0.27
3438.97	.00	Mn^+-Fe	4^2	4	800	1.17	3484.96	.98	Fe-Ni	4^3	2	400	3.68^2
3440.62	.63	Fe	20	12	1500	0.00	3485.37	.36	Fe-Co	6	4	500	2.19
3441.01	.02	Fe	15	10	1500	0.05	3485.94	.90	V^+-Ni	5	2	500	1.09
3441.97	.98	Mn^+	6	20	1500	1.77	3488.09	.07	−Ni	3^2	5	600	3.59
3443.22	.18	Ti^+-Fe	3^3	3	800	2.04	3488.68	.68	Mn^+	4	12	1200	1.84
3443.87	.88	Fe	8	5	800	0.09	3489.42	.41	Co	5	1	400	0.92
3444.30	.33	Ti^+	4	12	1200	0.15	3489.76	.75	Ti^+	2	6	800	.13
3445.09	.13	Fe	5	3	500	2.19	3490.60	.60	Fe	10	8	800	.05
3445.58	.61	Cr	2	2	400	......	3491.03	.06	Ti^+	5	10	1200	.11
3446.27	.27	Ni	15	7	800	0.11	3492.93	.98	Ni	10	5	800	0.11
3447.30	.29	Fe	4	3	600	2.19	3493.14	.18	V^+	0	2	800	1.07
3448.87	.83	Y^+-Fe	1^2	2	500	0.41	3493.46	.42	Ti-Fe-	3^2	2	600	0.02
3449.21	.18	Co	5	2	400	.58	3494.18	.17	Fe	2	1	600	2.41
3449.48	.45	Co-Fe	6	2	400	0.43	3494.64	.64	Fe-Cr^+	3^2	4	600	2.47^2
3450.31	.34	Fe	5	3	600	2.21	3495.34	.32	Cr^+-Fe	5^2	3	600	2.44
3451.90	.92	Fe	3	2	400	2.21	3495.68	.73	Mn^+-Co-†	7^3	6	800	1.85
3452.47	.48	Ti^+	1	5	800	2.04	3496.18	.18	Zr^+-Y^+	3^2	10	1200	0.04
3452.89	.91	Ni	6	4	600	0.11	3497.00	.01	Mn^+-Fe	9^4	4	800	1.82
3453.32	.34	Cr	0	1	400	2.53	3497.57	.53	Mn^+	3	5	800	1.84
3453.56	.52	Co	5	3	400	0.43	3497.87	.84	Fe	8	5	800	0.11
3454.19	.17	Ni^+-Ti	1	3	600	2.94	3499.12	.11	Ti-Er^+	0	2	600	1.06
3455.30	.25	Co-	5	2	400	0.22	3500.43	.43	Ti^+-Fe	5^2	5d	800	0.12
3456.44	.40	Ti^+	3	10	800	2.05	3500.89	.86	Ni	6	2	600	.16
3457.64	.58	Zr^+	0	2	400	0.56	3502.26	.29	Co	6^2	3	600	.43
3458.40	.43	Ni-Fe	11^2	6d	800	0.21	3502.65	.62	Ni-Co	4^2	3	600	0.00
3459.43	.44	Fe	2	1	400	......	3504.44	.44	V^+-Fe	2	3	800	1.09
3459.92	.93	Mn^+-Fe	6^3	3	800	1.17	3504.88	.89	Ti^+-Fe	5^2	18	1500	1.88
3460.32	.33	Mn^+	4	18	1500	1.80	3505.63	.61	Zr^+	2^2	3	600	0.16
3461.46	.50	Ti^+	5	12	1200	0.13	3506.43	.42	Co-Fe	9^3	3d	600	.51
3461.68	.67	Ni	8	5	800	0.02	3507.57	.62	Ni-Fe	4^2	2	400	.16
3462.79	.82	Co	6	2	400	0.63	3508.40	.46	Fe-	6^3	3	400	......
3463.18	.21	Zr^+-Fe	2^2	4d	600	1.48	3509.86	.85	Co-Fe	4	2	400	.58
3464.12	.14	Sr^+-Fe	4^3	4d	600	3.03	3510.33	.35	Ni-Zr^+	10^2	5	600	0.21
3465.79	.80	Ti^+-Co-*	12^4	10d	1000	2.05	3510.87	.85	Ti^+	5	15	1500	1.88
3466.67	.69	Fe	6^3	2	400	0.85	3511.86	.84	Cr^+	2	2	600	2.47
3467.61	.59	Ni-Cr	5^2	3	400	0.16	3512.63	.65	Co	5	3	400	0.58
3468.78	.81	Fe^+-Fe	4^3	5	800	2.55^2	3513.52	.48	Co	5	2	400	.10
3469.60	.63	Fe-Ni	5^2	2	400	2.60	3513.85	.83	Fe	7	3	500	0.85
3471.36	.32	Fe-Co	6^2	5	600	2.27	3514.03	.97	Ni^+-Ni	7^2	5	800	2.85
3472.60	.56	Ni-	7^2	6	600	0.11	3515.01	.06	Ni	12	7	800	0.11
3473.61	.64	Fe-Cr	3^3	2	400	2.70	3516.22	.22	Ni	2	1	400	3.52
3474.11	.11	Mn^+	4^2	15	1500	1.80	3516.55	.49	Fe	4^2	2	400	......

* *Fe*. † *Ti*.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3517.33	.31	V^+	3	6	800	1.12	3561.72	.76	Ti^+-Ni	5^3	5d	800	0.57
3518.32	.35	Co	5	2	400	1.04	3564.15	.13	Fe-Co	4	2	400	1.60
3518.81	.78	Fe	6^2	2	400	2.19	3564.49	.54	Ti-Fe	5^2	3	400	1.44
3519.74	.76	Ni	7	3	400	0.27	3565.37	.38	Fe-Ti^+	15^2	12	1200	0.95
3520.23	.26	Ti^+	2	10	1000	2.04	3565.94	.97	Ti^+	1	3	600	1.16
3520.88	.85	Zr^+-Fe	2	2	400	0.56	3566.15	.18	V^+-Cr	2	3	600	1.07
3521.32	.27	Fe	8	4	600	.91	3566.43	.38	Ni	10	3	600	0.42
3521.57	.57	Co	7^2	2	400	0.43	3567.00	.00	Fe-	3^2	2	500	2.86
3521.77	.84	Fe-V^+	2	1	400	2.21	3567.73	.71	Sc^+	6^2	8	1000	0.00
3522.90	.91	Fe	2	1	400	......	3568.59	.64	Fe-Co	6^2	2d	400	2.86
3523.47	.44	Co-Ni	4	3	400	0.63	3569.55	.51	Co-Mn	11^3	3d	400	0.92
3524.12	.16	Fe	6^2	3	400	2.27	3570.14	.12	Fe-Mn	24^2	15	1200	.91
3524.50	.54	Ni	20	12	800	0.02	3571.96	.94	Ni-Fe	11^2	5	500	.16
3524.78	.74	V^+-	1	2	400	1.09	3572.52	.53	Sc^+-Zr^+	10^2	18	1200	.02
3525.77	.77	Zr^+-Co-*	6^2	4	600	0.36	3573.39	.40	Ti^+-Fe	12^5	7d	800	.57
3526.31	.31	Fe	9^4	4	600	2.27	3573.97	.91					
3526.75	.78	Co-Fe	10^2	4	600	0.00	3574.43	.42	Cr-	1	1	400	......
3527.79	.80	Fe	5	3	500	2.84	3575.00	.03	Co-Fe	8^2	3	500	.58
3529.02	.00	Co-Ni	4^2	2	400	0.17	3575.35	.38	Co-Fe	4^2	2	500	0.10
3529.71	.71	Co-Fe	9^3	3	600	0.51	3576.00	.98	Fe	4	3	500	2.86
3530.72	.78	V^+	3	8	1000	1.07	3576.38	.36	Sc^+	7^2	15	1200	0.01
3531.63	.68	Mn-Fe	6^3	3	600	2.27	3576.89	.86	Zr^+	1	5	800	0.41
3532.00	.05	Mn	7^2	3	600	2.27	3577.83	.88	Mn	5	3	500	2.10
3532.50	.58	Fe	4	2	400	......	3578.25	.33	Fe-Zr^+-	5^2	3	400	1.20^2
3533.21	.19	Fe-Co	17^3	4	800	2.86	3578.73	.69	Cr	10	12	1200	0.00
3533.89	.86	Ti^+	1	4	800	2.05	3580.96	.93	Sc^+	5	10	1000	.00
3534.91	.92	Fe-	3	2	400	1.48	3581.22	.21	Fe	30	20	1500	0.86
3535.41	.41	Ti^+	4	20	1200	2.05	3581.76	.78	Fe-	5^3	2	400	2.68
3535.69	.73	Sc^+	3	3	800	0.31	3582.20	.25	Fe-	7^2	3	500	......
3536.56	.57	Fe	7	3	500	2.86	3582.60	.65	Fe	5^2	2	500	......
3537.80	.76	Fe-Fe^+	9^3	2	400	2.82	3583.87	.91	CN-‡	3	2	600	......
3538.26	.28	V^+-Fe	2^2	2	400	1.12	3584.62	.64	Y^+-Fe	8^2	7	800	0.10
3540.08	.13	Fe	5	2	400	......	3584.95	.97	Fe	6	3	800	......
3541.08	.10	Fe	7	4	600	2.84	3585.30	.29	Fe-Co	12^2	15	1200	0.95
3542.16	.15	Fe	9^2	5d	600	2.85	3585.63	.67	Fe-Cr^+-§	8^2			
3543.36	.33	Co-Fe	4^2	2	400	1.87	3586.53	.54	Mn	4	3	500	2.13
3545.23	.20	V^+	4	10	1000	1.09	3586.85	.92	Fe-	11^2	5	500	0.99
3545.69	.71	Fe	8^2	2	400	2.84	3587.20	.21	Ti^+-Co	9^2	8	800	0.60
3547.25	.20	Fe	6^2	2d	400	2.80	3587.59	.64	Fe	8^2	3	400	2.84
3547.98	.00	Mn-Ni	13^3	5	500	2.29	3587.98	.94	Zr^+-Ni	6	5	600	0.32
3549.05	.01	Y^+	2	7	1000	0.13	3588.62	.62	Fe	4	2	400	2.82
3550.59	.60	Co	4	1	400	.17	3589.13	.11	Fe	4	2	400	0.86
3551.41	.45	Ni-Fe	5^2	2	400	.16	3589.72	.70	V^+-Sc^+	10^2	10	800	1.07
3551.92	.96	Zr^+	1	7	800	0.09	3590.48	.49	Sc^+-‖	4^2	8	800	0.02
3552.92	.85	Fe-Co	7^3	3	600	2.86	3591.43	.42	Fe	4^2	5	600	2.84
3553.63	.65	Fe-Ni	8^2	2	500	0.11^2	3592.00	.03	V^+	2	7	800	1.09
3554.12	.12	Fe	5	3	600	0.95	3592.67	.68	Fe	3	2	400	......
3554.92	.94	Fe	9	4	600	2.82	3593.41	.45	V^+-Cr-*	12^2	12	1000	1.12
3556.71	.75	Zr^+-V^+-*	11^4	15d	1000	0.46	3594.78	.72	Fe-Co	9^2	4	500	2.84
3558.52	.53	Sc^+-Fe	8	10	1000	.01	3595.20	.24	Fe-Mn	3^2	2	400	2.86
3559.10	.08	Fe-CN	1	1	400	......	3596.03	.06	Ti^+	4	10	1200	0.60
3559.50	.52	Fe	3	2	400	......	3597.03	.05	Fe-	5	2	400	......
3560.91	.90	Co	4	3	500	0.63	3597.71	.71	Ni	8	4	600	0.21

* *Fe*. ‡ Third head of fourth *CN* band. § Second head of fourth *CN* band. ‖ First head of fourth *CN* band.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3599.00	.02	*Fe*	6^3	2	500	2.87
3599.58	.63	*Fe*	3	2	500	......
3600.77	.74	*Y*$^+$	3	12	1200	0.18
3601.89	.92	*Y*$^+$	1	8	800	0.10
3602.50	.51	*Fe*	7^2	2d	500	2.85
3603.17	.21	*Fe*	5	4	500	2.68
3603.84	.81	*Cr*$^+$-*Fe*	7^3	7	800	2.70
3604.38	.35	*Fe-Ti*	3^2	1	500	2.87
3605.33	.33	*Cr-Co-**	16^3	8d	800	0.00
3606.69	.70	*Fe*	6	4	600	2.68
3607.46	.50	*Mn-Zr*$^+$	3^2	1	500	2.13
3608.17	.15	*Fe*	4	3	500	2.84
3608.86	.87	*Fe*	20	12	1200	1.01
3609.36	.33	*Ni*	5	3	500	0.11
3609.53	.47	*Cr*	2	1	400	......
3610.18	.20	*Fe-Ti*	7^2	4	600	2.86
3610.63	.58	*Ni-Fe*	8^2	4	600	0.11
3611.06	.05	*Y*$^+$	2	8	800	0.13
3611.81	.78	*Zr*$^+$-*Co*	2^2	2	400	1.74
3612.72	.74	*Ni*	6	2	400	0.27
3613.09	.04	*Zr*$^+$-*Fe*	6^3	5	600	.04
3613.82	.78	*Sc*$^+$	7^2	25	1500	0.02
3614.75	.78	*Zr*$^+$	2	6	600	.36
3615.71	.67	*Cr-Fe*	3	1	400	0.00
3616.20	.18	*Fe-*	3^2	2	400	......
3616.57	.57	*Fe*	4	2	400	2.86
3617.34	.37	*Fe-*	5^2	2	500	......
3617.82	.80	*Fe*	6	4	500	......
3618.77	.78	*Fe*	20	12	1200	0.99
3619.42	.40	*Ni*	8	6	800	0.42
3619.76	.78	*Fe*	2	1	400	2.39
3620.23	.25	*Fe*	2	1	400	......
3620.46	.47	*Fe*	3	2	500	......
3621.14	.14	*Fe-V*$^+$	5^2	3	600	3.23
3621.49	.47	*Fe*	6	4	600	2.72
3621.99	.01	*Fe*	6	4	600	2.75
3623.30	.29	*Fe*	7^2	4d	600	2.39
3623.89	.85	*Fe-Mn-*	5^2	2	500	2.85
3624.39	.42	*Ni-Ca-**	10^3	5d	800	0.00
3624.84	.84	*Ti*$^+$-*Fe*	5	12	1200	1.22
3626.86	.90	*Fe*	4^2	2d	400	3.40
3627.85	.81	*Co*	4	2	400	0.51
3628.71	.71	*Y*$^+$	2	5	800	.13
3630.01	.02	*Zr*$^+$	1	4	800	.36
3630.73	.74	*Sc*$^+$-*Ca*	7^2	20	1500	.01
3631.48	.47	*Fe*	15	12	1200	0.95
3632.01	.02	*Fe-Co*	5^2	2	400	2.53^2
3632.60	.63	*Fe-Cr*	4^2	2	500	......
3632.96	.02	*Fe-*	6^2	2	500	......
3633.13	.14	*Y*$^+$	2	6	1000	0.00
3634.25	.27	*He-Fe*	6^2	4	1200	20.87
3635.34	.36	*Ti-Fe*	6^2	3d	500	0.00
3636.18	.19	*Fe*	5^2	2	500	......

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3636.56	.55	*Zr*$^+$-*Cr*	3^2	2	500	0.46
3637.84	.87	*Fe*	4	2	400	2.93
3638.31	.30	*Fe*	3	2	400	2.75
3639.43	.43	*Co-Zr*	4^3	1	400	1.95
3639.80	.80	*Cr*	2	1	400	2.53
3640.41	.40	*Fe-Cr*	6	4	500	2.72
3641.35	.34	*Ti*$^+$	4	15	1200	1.23
3641.81	.82	*Cr-Co*	2^2	2	500	2.53
3642.74	.73	*Sc*$^+$-*Ti*	12^3	18	1200	0.00
3643.75	.71	*Fe-*	9^3	3	500	2.93
3644.41	.42	*Ca*	5	2	500	1.89
3644.83	.87	*Ca-Fe*	6^3	3	500	1.89
3645.34	.31	*Sc*$^+$-*La*$^+$	6^2	12	1200	0.02
3646.17	.20	*Ti-Gd*$^+$	1	2	400	0.00
3647.41	.43	*Fe*	4	3	400	1.55
3647.81	.85	*Fe*	12	12	1500	0.91
3649.35	.31	*Fe-Co*	7^2	3	500	0.00
3649.56	.51	*Fe*	5	3	500	......
3650.19	.18	*Fe*	9^2	4	500	2.42
3651.08	.11	*Fe-*	6	2	400	2.84
3651.47	.48	*Fe*	7	3	400	2.75
3651.77	.80	*Sc*$^+$	4	10	1200	0.01
3653.48	.50	*Ti*	5	3	400	0.05
3653.93	.89	*Fe-Cr*	6^3	2	400	2.42
3654.66	.62	*Ti-Fe*	3^2	2	400	0.00
3655.64	.56	*Fe*	6^2	3	500	2.82
3656.19	.24	*Cr-Fe*	5^2	3	500	2.53
3656.66	(.67)	*H*37	....	2	500	10.16
3657.26	(.27)	*H*36	....	2	500	10.16
3658.05	(.93)	*H*35	....	3	750	10.16
	.10	*Ti*	1			0.02
3658.66	(.64)	*H*34	....	2	750	10.16
3659.70	.64	*Ti*$^+$-*Fe*	10^2	12d	1000	1.58
3660.33	(.28)	*H*32	....	3	1000	10.16
	.33	*Fe*	2			......
3661.28	(.24)	*H*31	....	3	1000	10.16
3662.23	.24	*Ti*$^+$	5	15	1200	1.56
	(.26)	*H*30	....			10.16
3662.90	.84	*Fe-Cr*	4	2	400	2.53
3663.42	.38	*Fe*	9^3	7	1200	3.38
	(.42)	*H*29	....			10.16
3664.66	.62	*Y*$^+$	2	15	1500	0.18
	(.68)	*H*28	....			10.16
3666.09	(.10)	*H*27	....	12	1500	10.16
3666.74	.71	*Fe-Sc*$^+$	4^2	2	400	0.02^2
3667.26	.26	*Fe*	4	3	400	......
3667.74	(.69)	*H*26	....	12	1800	10.16
3668.53	.48	*Zr*$^+$-*Y*$^+$	0^2	3	400	0.41
3669.46	(.47)	*H*25	....	18	1800	10.16
3670.08	.06	*Fe-Co*	5^2	2	400	2.83
3670.46	.43	*Ni*	5	5	400	0.16
3671.33	.28	*Zr*$^+$	0	18	2000	0.71
	(.48)	*H*24	....			10.16

* *Fe.*

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3671.68	.68	Ti	3	1	400	0.05
3673.08	.09	Fe	3	2	400	......
3673.82	(.77)	H23	....	18	2000	10.16
3674.74	.76	Zr^+-Ti^+	3^2	10	600	0.32
3675.34	.30	Sc^+-Ca	1	3	400	2.51^2
3676.34	.32 (.37)	Fe-Cr H22	6	20	2200	2.55 10.16
3677.37	.38	Fe	7^2	4	500	......
3677.79	.76	Cr^+-Fe	13^4	15	1000	2.69
3679.34	(.36)	H21	....	25	2500	10.16
3679.96	.92	Fe .	9	4	600	0.00
3680.97	.94	Fe-	9^3	2d	400	......
3682.21	.22	Fe	7^2	2	500	2.93
3682.82	(.81)	H20	....	25	2500	10.16
3684.12	.12	Fe	7	3	500	2.72
3685.25	.20	Ti^+	10	80	6000	0.60
3686.10	.09	Fe-V	9^2	3	600	2.93
3686.83	(.84)	H19	....	30	3000	10.16
3687.62	.58	Fe	10^2	4	600	0.86
3688.48	.45	Ni-Fe	7^2	3	500	0.27
3689.50	.44	Fe-	9^2	5	500	2.93
3690.70	.73	Co-Fe	4	2	400	2.00
3691.62	(.56)	H18	....	35	3000	10.16
3692.24	.23	V	1	1	400	0.27
3692.67	.65	Fe-Er^+	2	3	600	......
3693.02	.03	Fe	3	2	400	......
3693.48	.48	Co-	1	2	400	2.03
3694.13	.10	Fe-Ni-†	10^4	12	800	3.02
3695.00	.05	Fe	5	5	600	......
3696.34	.34	Ti^+-	1^2	3	600	1.56
3697.21	(.16)	H17	....	40	3500	10.16
3698.14	.16	Zr^+-Ti	2	8	600	1.01
3698.60	.60	Fe	4	3	500	......
3699.16	.14	Fe	3	4	500	......
3700.39	.34	V^+	1	5	600	2.50
3701.09	.10	Fe	8	5	600	2.98
3702.27	.26	Fe-Co-†	12^4	6d	600	1.60
3703.89	(.86)	H16	....	45	4000	10.16
3704.97	(.01)	He	....	4	1200	20.87
3705.57	.58	Fe	9	8	1200	0.05
3706.11	.10	Ca^+-Ti^+-	9^2	20	1200	3.11
3707.08	.05	Fe	5	4	600	2.98
3707.48	.51	Ti-Co	4^2	2	400	2.01
3707.94	.88	Fe	10^2	5	600	0.09
3708.69	.72	Co-Fe-†	2^2	2	600	2.03
3709.32	.26	Fe	8	8	800	0.91
3709.90	.95	Ti	0	2	400	1.05
3710.34	.29	Y^+	3	20	800	0.08
3712.06	(.98)	H15	....	50	5000	10.16
3712.89	.93	Cr^+-Mn	5^2	10	800	2.70
3713.51	.56	La^+	−2	2	400	0.17
3714.85	.79	Zr^+	0	2	500	0.52
3715.17	.17	Cr^+	2	4	800	3.09

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3715.43	.48	V^+-Ni	4	5	800	3.82^2
3716.40	.45	Fe	7	4	500	3.35
3717.40	.40	Ti	2	2	400	0.00
3718.40	.41	Fe	4	3	400	......
3719.94	.95	Fe	40	35	2000	0.00
3722.00	(.94)	H14	....	55	5600	10.16
3722.55	.56	Fe-Ni-†	9^2	6	1000	0.09
3723.55	.61	Ti^+	1	2	600	1.56
3724.06	.09	Ti^+	1	6	800	1.58
3724.40	.39	Fe	6	6	800	2.27
3725.00	.00	Ti-Ni	2^2	4	500	1.06
3726.98	.01	Fe	7^2	4	600	0.15
3727.39	.40	V^+-Cr^+	3^3	8	800	1.68
3727.68	.65	Fe-Zr^+	5^2	8	800	0.95
3728.38	.35	V^+-Ce^+-*	5^2	4	400	2.50
3729.86	.82	Ti	3	3	400	0.00
3730.39	.43	Co-Fe	5^2	5	500	1.87
3731.20	.18	Zr^+-Fe	7^3	5	500	1.74
3731.98	.01	Cr-Mn	3^2	2	400	0.00
3732.40	.41	Fe-Co	6	4	500	1.87^2
3732.76	.75	V^+	2	4	600	......
3733.33	.33	Fe	7	7	800	0.11
3734.45 3734.91	(.37) .88	H13 Fe	 40	70	5600	10.16 0.86
3735.46	.41	Fe-Nd^+	5^2	2	600	2.93
3737.00	.88 .14	Ca^+-Ni Fe	8^2 30	40	2000	3.14 0.05
3738.29	.33	Fe-Cr^+	6^2	4	600	3.09^2
3739.15	.19	Ni-Fe	5^2	4	600	0.16
3739.75	.75	Fe-Ni	6^3	4d	600	3.92^2
3741.06	.06	Ti	4	4	500	0.02
3741.64	.65	Ti^+	4	25	2000	1.58
3742.70	.66	Fe-Cr	6^3	5	800	2.93
3743.49	.53	Fe-Cr-	12^5	10d	1000	0.99
3744.11	.11	Fe	4	3	400	3.02
3745.78	.72	Fe	14^2	30	2000	0.09
3746.53	.51	Fe	3^2	2	400	2.19
3747.60	.55	Y^+	1	5	600	0.10
3747.60–3748.25	.00	Ti^+	1	20	1500	2.59
3748.25	.27	Fe	10			0.11
3749.50	.49	Fe	20	15	1000	0.91
3750.25	(.16)	H12	....	70	6000	10.16
3751.65	.59	Zr^+	1	2	500	0.97
3752.21	.27	Fe	4^2	3	400	3.02
3752.86	.86	Ti	4	4	400	0.05
3753.55	.62	Fe-Ti	6	4	400	2.17
3754.51	.52	Fe-Cr^+	4^2	3	350	3.09^2
3755.41	.45	Co	1	1	350	2.07
3756.04	.07	Fe	3	2	350	......
3757.16	.12	Fe-Cr	7^3	5	600	2.53
3757.66	.69	Ti^+-Cr	4	10	1000	1.56
3758.25	.25	Fe	15	10	1000	0.95
3759.33	.30	Ti^+	12	70	6000	0.60

* Fe. † Ti.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3761.33	.32	Ti^{+}	7	70	6000	0.57	3801.74	.74	Fe	5^{2}	4	600	......
3761.88	.88	Ti^{+}	3			2.58	3802.28	.29	Fe	2	2	450	......
3762.35	.34	Fe-Ni-†	5^{4}	2	400	3.35	3802.71	.77	CN	1^{2}	2	450	......
3763.80	.80	Fe	10	15d	1000	0.99	3803.00	.04	Ce^{+}-CN	1^{2}	4	500	......
3764.54	.55	Zr-CN	1^{5}	2	800	0.00	3803.42	.48	V-CN	0	2	500	0.28
3765.49	.55	Fe	6	6	800	......	3804.00	.02	Fe	3	2	600	......
3766.68	.71	Zr^{+}-Fe	4^{2}	5	750	0.41	3804.65	.72	Cr-V-	4^{3}	4	600	3.00
3767.15	.21	Fe	8	10	1000	1.01	3805.32	.35	Fe	6	4	750	......
3768.21	.17	Cr-CN-*	6^{3}	6d	600	2.53	3806.15	.19	Fe-CN	3^{2}	2	600	......
3770.72	(.64)	H_{11}	....	80	6000	10.16	3806.75	.72	Fe-Mn	8	4	600	2.10^{2}
3771.66	.66	Ti	2	4	400	0.05	3807.31	.35	Fe-Ni	12^{4}	8	600	2.21
3772.57	.55	Ni-	3^{2}	2	400	0.21	3808.09	.11	Cr-Fe-	4^{4}	3	450	3.00
3773.76	.76	Fe-CN	4^{5}	4d	500	3.02	3808.85	.81	Fe-CN	4^{2}	5d	450	2.55
3774.38	.34	Y^{+}	3	20	800	0.13	3809.51	.58	Mn-V	4	2	450	2.13
3774.85	.83	Fe	4	3	600	2.21	3810.84	.83	Fe-CN	4^{2}	5	500	2.60
3775.54	.58	Ni	7	5	600	0.42	3811.40	.34	Ti-CN	2^{2}	2	450	1.86
3776.02	.06	Ti^{+}	2	7	800	1.58	3812.00	.96	Fe-CN	3^{3}	3	500	2.75
3776.48	.48	Y^{+}-Fe	4^{2}	4	600	0.13	3813.10	.04	Fe	7^{2}	7	1000	2.58
3777.42	.46	Fe	3	3	500	2.55	3813.49	.52	Ti^{+}-Fe-	4^{2}	6	700	0.60
3777.98	.00	Ni-CN	3^{3}	3	500	0.02	3814.53	.56	Ti^{+}-Fe-	7^{2}	10d	700	0.57
3778.30	.33	V^{+}-Fe	3	3	500	......	3815.82	.85	Fe	15	15	1500	1.48
3778.70	.66	Fe-CN	6^{3}	3	......	......	3816.33	.35	Fe-Co	3	2	400	2.19
3779.39	.43	Fe	4	4	450	2.55	3817.65	.65	Zr^{+}-Fe-	3	5	750	0.52
3780.48	.47	Zr-CN	1^{2}	2	450	......	3818.31	.30	Y^{+}-V	2^{2}	3	750	0.13
3780.95	.95	Fe-	6^{2}	2	450	......	3819.15	.18	GN	3^{3}	4d	750	......
3781.66	.63	Ce^{+}-CN	1^{2}	2	450	......	3819.63	(.60)	He	....	10	5000	20.87
3782.26	.25	CN	0^{2}	2	500	......	3820.43	.44	Fe	25	20	1500	0.86
3783.47	.49	Ni-	8^{2}	8	750	0.42	3821.16	.19	Fe	4	2	500	......
3784.15	.14	CN	2^{4}	2	500	......	3821.79	.82	Fe-CN	5^{2}	5d	700	2.60
3785.36	.32	CN	2^{3}	2	500	......	3822.81	.86	V-CN	1	2	500	0.28
3785.58	.55	CN	1^{2}	2	500	......	3823.56	.51	Mn-Cr	4	3	500	2.13
3785.90	.94	Fe-	5^{3}	4	600	......	3823.99	.99	Mn-Fe	2^{2}	2	500	2.15
3786.17	.18	Fe-Ti	4	4	600	2.82	3824.46	.45	Fe	6	15	1500	0.00
3786.68	.68	Fe	5	4	600	1.01	3825.32	.27	CN	1^{2}	2	700	......
3787.11	.17	Fe-CN	1	2	450	2.58	3825.86	.89	Fe	20	20	1500	0.91
3787.94	.89	Fe	9	6	750	1.01	3826.60	.68	CN-Fe	4^{3}	4d	600	......
3788.66	.70	Y^{+}	2	18	800	0.10	3827.31	.32	Zr^{+}-CN	2^{2}	2	600	......
3790.09	.10	Fe	5	5	750	0.99	3827.79	.83	Fe	8	10	1200	1.55
3790.42	.40	V-Cr	4^{3}	2	500	3.00^{2}	3829.35	.37	Mg	10	40	6000	2.70
3790.78	.79	La^{+}-Fe	3^{2}	4	750	0.12	3830.68	.77	Fe-CN	5^{4}	5	800	2.60
3791.36	.38	Cr	1	1	500	3.00	3831.06	.03	CN	3d	5	800	......
3792.22	.20	Fe-Cr	4^{2}	4	600	3.00^{2}	3832.34	.31	Mg	15	50	6000	2.70
3792.78	.76	Fe-CN	4^{2}	3	600	2.21	3833.15	.13	Fe-Ni-	8^{3}	6	750	2.55
3793.35	.33	Cr-Fe	2^{2}	2	500	3.02	3833.74	.70	CN	1^{3}	1	750	......
3793.60	.57	Ni-Fe	6^{2}	3	500	0.27	3834.26	.26	Fe-Mn	14^{2}	8	750	0.95
3794.31	.35	Fe-CN	4	3	500	......	3835.54	(.39)	H_{9}	....	100	7000	10.16
3794.76	.78	La^{+}	1	6	800	.24	3836.08	.09	Ti^{+}	2	2	750	0.60
3795.01	.01	Fe	8	7	800	0.99	3836.69	.53	CN	2	8	800	......
3796.25	.26	Zr^{+}-CN	1^{3}	3d	500	......		.77	Zr^{+}-Ti	1			0.56
3798.02	(.91)	H_{10}	....	90	6000	10.16	3838.30	.30	Mg	25	60	7000	2.70
3799.52	.56	Fe	7	7	750	0.95	3839.65	.71	Fe-Mn-	4^{2}	3	600	2.18^{2}
3800.06	.09	CN	2^{4}	3	500	......	3840.44	.45	Fe-CN	8	10	1200	0.99
3801.37	.40	Ce^{+}-CN	2^{3}	2	500	......	3840.74	.76	V-La^{+}	1	2	800	0.04

* *Fe.* † *Ti.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3841.07	.06	*Fe-Mn*	10	10	1200	1.60	3872.73	.72	*CN*	1	2	750	......
3841.88	.90	*Co-CN*	6^4	5	700	0.92	3873.05	.05	*Co-Fe-*	6^3	6	750	0.43
3843.13	.11	Zr^+*-Fe-*	10^4	10d	800	0.36	3873.90	.86	*Co-Fe-*	8^2	6	750	.51
3844.00	.00	*Mn-CN*	2	2	600	2.18	3874.75	.75	*CN*	3^2	2	500	......
3844.29	.27	*CN-V*	4^2	3	600	0.00^2	3875.19	.19	*Ti-V-*	4^2	3	500	0.00
3845.14	.15	*Fe-CN*	5^3	2	600	......	3875.78	.78	*CN*	2	2	600	......
3845.44	.47	*Co-CN*	8	5	600	0.92	3876.05	.05	*Fe*	5	4	750	1.01
3846.26	.22	*Fe-Ti*	5^3	2	600	......	3876.35	.40	*CN*	2^3	3	600	......
3846.79	.78	*Fe-CN*	8^4	8	750	3.35	3876.92	.92	*CN-Co*	8^2	5	600	0.43^2
3847.92	.89	*CN*	3^3	2	600	......	3878.01	.01	*Fe-CN*	8	8	1500	.95
3848.93	.95	La^+*-Cr-*	4^2	5	750	0.00	3878.65	.63	*Fe-*V^+*-*	11^3	20		.09
3849.45	.45	*Cr*	2^2	2	600	0.98	3879.59	.56	*CN*	4^4	2	600	......
3849.93	.98	*Fe*	10	8	1000	1.01	3880.19	.17	*CN*	3^5	2	600	......
3850.82	.82	*Fe*	4	4	750	0.99	3880.68	.68	*CN*	1	4	600	......
3851.22	.29	*CN*	2	2	600	......	3881.25	.22	*CN*	5^5	5	600	......
3851.60	.60	*CN*	1^3	2	600	......	3881.91	.88	*CN-Co*	2	4	700	0.58^2
3852.50	.48	*Fe-CN*	7^3	4	800	2.17	3882.25	.30	*CN*	2	6	750	......
3853.39	.38	*CN-Fe-*	3^2	4	750	2.94^2	3882.50	.50	*CN*	3^3	10	750	......
3854.01	.98	*CN*	1^2	3	750	......	3883.29	.32	*CN-Cr*§	3^2	15	750	0.98^2
3854.45	.47	*CN-Fe*	4^2	6	800	......	3884.32	.36	*Fe-*	3^2	3	500	......
3854.81	.86	*CN**	1	6	800	......	3885.32	.38	*Fe-Cr*	8^3	3	500	2.41
3855.58	.61	*Cr-Fe*	5^2	4	750	2.70	3886.32	.30	*Fe-*La^+	15	25	1500	0.05
3856.26	.32	*Fe-*Si^+	9^2	20	1500	0.05	3887.02	.06	*Fe*	7	5	800	0.91
3856.84	.77	*CN*	3^2	3	750	......	3889.20	(.06)	$H\zeta$	....	120	8500	10.16
3857.70	.67	*Cr-CN*	6	5	750	2.70	3890.41	.40	*Fe*	2	3	500	......
3858.36	.30	*Ni*	7	6	750	0.42	3890.85	.85	*Fe*	3	4	600	......
3858.72	.69	*CN*	2	4	750	......	3891.41	.36	*Zr-*Nd^+	2^3	4	600	0.15
3859.87	.92	*Fe*	20	35	2500	0.00	3891.93	.90	Ba^+*-Fe*	5^2	5d	600	2.50
3860.60	.63	*CN-V*	3	3	750	......	3893.02	.96	*V-Fe*	4^3	4	600	0.04
3861.23	.23	*Co-Fe*	7^2	6	750	1.04	3893.38	.40	*Fe*	4	4	600	2.94
3861.73	.71	*CN*†	7^5	6	750	......	3894.12	.08	*Co-Cr*	8^2	6	800	1.04
3862.49	.53	Si^+*-CN*	3^2	5	900	6.83	3895.06	.08	*Co-Ti*	8^3	4	600	0.63
3863.42	.40	Nd^+*-CN*	3	5	750	......	3895.68	.67	*Fe*	7	15	1200	0.11
3864.36	.35	*CN*	4^2	5	750	......	3896.[illegible]	.18	V^+*-V*	1^2	4	800	1.39
3864.87	.88	*V*	3	4	600	0.02	3896.70	.65	Ce^+*-Fe*	2^3	2	650	3.64^2
3865.12	.15	*CN*	3	5	750	......	3897.75	.71	*Fe-Cr*	6^4	5	800	......
3865.51	.54	*Fe*	7	7	1000	1.01	3898.05	.01	*Fe*	5	5	800	1.00
3866.00	.99	*CN*	3	3	750	......	3898.40	.42	*Mn-Ti*	3^2	2	500	0.00^2
3866.79	.83	*CN*	2	3	750	......	3899.09	.08	V^+*-Fe*	5^2	4	800	1.80
3867.20	.23	*Fe*	3	3	750	3.00	3899.70	.72	*Fe*	8	10	1200	0.09
3867.62	.63	*CN-V*	1	3	750	0.04^2	3900.54	.54	Ti^+	5	40	2000	1.13
3867.94	.93	*Fe-CN*	2	3	750	2.58	3901.72	.76	Nd^+*-*	5^2	5d	600	......
3868.38	.41	*CN-Ti*	1	3	750	1.97	3902.39	.41	*V-*	6^3	2	600	0.07
3868.75	.74	*CN*	1	3	750	......	3902.97	.95	*Fe-Cr*	10	8	1000	3.23
3869.13	.18	*CN*	1	3	750	......	3903.19	.23	V^+*-Cr*	3^2	6		1.47
3869.51	.56	*Fe-CN*	3	4	750	2.72	3903.82	.89	Fe-	7^2	4	700	2.98
3869.89	.92	*CN*	1	3	750	......	3904.77	.79	*Ti*	3	3	600	0.90
3871.09	.10	*CN*	3^4	8	750	......	3905.53	.53	*Si*	12	12	800	1.90
3871.37	.39	*CN*‡	2d	8	750	......	3905.92	.91	Nd^+*-*	3	3	600	......
3871.80	.78	*Fe-*La^+	3^2	3	750	2.94	3906.48	.49	*Fe*	10	10	800	0.11
3872.20	.17	*CN*	3^3	3	750	......	3906.72	.76	*Fe-V*	4	8	600	1.05^2
3872.55	.51	*Fe*	6	5	1000	0.99	3906.99	.96	Eu^+	1	2	600	......

* Fourth head of third *CN* band. † Third head of third *CN* band. ‡ Second head of third *CN* band.
§ First head of third *CN* band.

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3907.45	.48	*Fe-Sc*	3	3	600	0.00^2	3948.67	.73	*Ti-Fe*	8^2	4	600	0.00
3907.91	.94	*Fe*	5	4	600	......	3949.07	.10	*La*$^+$*-Ca*	1	8	750	0.40
3908.77	.76	*Cr*	4	3	600	1.00	3949.96	.96	*Fe*	5	5	600	2.17
3909.65	.67	*Fe-V*	4	3	500	3.27	3950.33	.36	*Y*$^+$	2	10	800	0.10
3909.90	.88	*Fe-Co*	8^2	3	500	2.83	3951.20	.17	*Fe-Nd*$^+$	5	3	750	......
3910.68	.75	*Fe-V*	6^2	3	500	2.75	3951.97	.97	*V*$^+$*-Mn*	2	6	800	1.47
3911.15	.19	*Ti-Nd*$^+$	0	2	500	2.03	3952.66	.66	*Fe-Ce*$^+$	7^2	4	600	2.68
3911.84	.83	*Sc*	2	2	500	0.02	3953.03	.03	*Fe-Co-*	10^4	4	600	3.00
3912.18	.16	*Ni-Cr*	4^2	4	500	3.78	3954.53	.54	*Ni-*	2	1	400	3.64
3913.55	.55	*Ti*$^+$*-Fe*	9^2	40	2500	1.11	3955.37	.35	*Fe-Ce*$^+$	5	2	400	3.27
3914.45	.40	*Fe-Ti-*	8^5	10d	750	0.05^2	3956.39	.40	*Ti-Fe*	8^2	5	600	0.02
3915.33	.35	*Fe-Cr*	2^2	3	500	......	3956.72	.68	*Fe*	6	6	600	2.68
3915.72	.74	*Cr-Dy*$^+$	8^2	8	800	3.00	3957.05	.04	*Ca-Fe*	7	8	750	1.88
3915.96	.98	*Zr*$^+$*-La*$^+$	2^2	4	800	0.23^2	3958.23	.22	*Zr*$^+$*-Ti*	5	20	800	0.52
3916.53	.54	*V*$^+$*-Fe-*	10^3	3	750	1.42	3959.48	.49	*Gd*$^+$*-*	0^2	1d	600	......
3917.24	.19	*Fe*	5	3	600	0.99	3960.33	.29	*Fe*	4	3	400	......
3918.34	.37	*Fe*	8^2	6	750	......	3961.51	.54	*Al*	20	35	2000	0.01
3918.66	.65	*Fe*	5	4	750	3.00	3962.98	.99	*Fe-Ti-*	6^2	5	800	3.27
3919.12	.12	*Fe-Cr*	6^2	2	500	2.98	3964.39	.43	*Fe-Ti*	5^2	2	600	0.02^2
3920.25	.27	*Fe*	10	15	1200	0.12	3964.72	(.73)	*He*	....	8	1200	20.52
3921.11	.05	*Cr*	3	2	600	0.98	3966.58	.63	*Fe-Zr*	6^3	5	500	3.20
3921.59	.61	*La*$^+$*-Ce*$^+$*-*†	9^3	4	600	0.23	3968.70	.49	*Ca*$^+$	700	175	14000	0.00
3922.46	.40	*Mn-V*	3^3	2	500	2.47	3970.25	.04	*He*	5	120	8500	10.16
3922.92	.92	*Fe*	12d	20	1500	0.05	3971.33	.33	*Fe*	5	4	400	2.68
3924.09	.12	*Mn-*	2^2	2	400	......	3971.89	.91	*Eu*$^+$*-Fe*	1^2	3	700	......
3924.53	.54	*Ti*	4	3	400	.02	3972.27	.26	*Ni-*	4^3	2	700	0.42
3925.20	.21	*V-Fe*	4	4	500	0.07	3973.60	.63	*V*$^+$*-Ca-*	6^3	5	750	1.42
3925.61	.65	*Fe*	5	3	500	2.82	3974.56	.62	*Co-Fe-*	13^4	5d	500	0.51
3925.98	.98	*Fe*	7^2	4	600	2.85	3975.21	.25	*Fe-Co*	3^2	2	400	2.46
3926.86	.90	*Nd*$^+$*-Cr*	2^3	3	600	......	3976.73	.72	*Fe-Cr-*	8^3	6d	500	2.53^2
3927.96	.97	*Fe*	10^2	20	1500	0.11	3977.77	.75	*Fe*	6	6	700	2.19
3929.16	.17	*Fe-La*$^+$	4^2	3	500	$.17^2$	3978.40	.42	*Fe*	3^2	3	500	2.82
3929.86	.89	*Ti*	2	2	500	.00	3978.70	.67	*Co-Ce*$^+$*-*	3	4	500	0.51
3930.26	.31	*Fe*	8	20	1500	0.09	3979.49	.52	*Co-Fe-*	7^2	5d	700	0.10
3931.15	.20	*V-Fe*	2^2	2	500	3.25^2	3980.97	.01	*Fe-Cr-*	5^4	4d	500	2.70^2
3933.90	.69	*Ca*$^+$	1000	200	14000	0.00	3981.81	.85	*Ti*$^+$*-Fe-*†	6^2	10	700	0.57
3935.90	.90	*Fe-Co*	4^2	3	500	2.82	3982.55	.56	*Y*$^+$*-Ti*	5^2	12	900	0.13
3937.36	.34	*Fe*	3	2	500	2.68	3983.17	.15	*Cr-Ce*$^+$	5^3	2	500	......
3938.35	.37	*Mg-*	6^2	8	900	4.33	3983.90	.95	*Fe-Cr*	7^2	6	600	2.72
3939.43	.36	*Fe*$^+$*-*	2^4	2	600	......	3984.30	.25	*Cr-Mn*	4^2	3	600	2.53
3940.17	.14	*Fe-Ce*$^+$	3^2	2	600	......	3984.64	.67	*Ce*$^+$	2	2	600	......
3940.87	.89	*Fe-Co*	5	4	600	0.95	3985.36	.38	*Fe-*	4^2	3	400	2.55
3941.30	.29	*Fe*	3	2	600	......	3986.18	.18	*Fe*	3	4	600	2.98
3941.89	.87	*Co-Ce*$^+$*-*	6^4	3	600	0.43	3986.73	.76	*Mg*	6	6	600	4.33
3942.43	.42	*Fe*	5^2	4	600	2.83	3987.15	.10	*Mn-Co*	5^3	4	500	3.12
3943.24	.23	*Fe-*	7^3	5	600	2.19	3987.56	.58	*Mn-Ti*	3^2	3	600	3.12
3944.03	.02	*Al*	15	25	2000	0.00	3988.47	.52	*La*$^+$	0	10	600	0.40
3944.71	.73	*Fe-Dy*$^+$	3^2	6	600	2.83	3989.09	.03	*Sc*$^+$*-*	5^2	1	500	.31
3945.19	.23	*Fe-Co*	6^2	8	600	0.92^2	3989.77	.81	*Ti-Fe*	7^2	6	600	.02
3945.97	.00	*Fe-*	2^3	2	500	......	3990.00	.03	*Cr-Nd*$^+$	2^2	4	600	......
3946.90	.93	*Fe-Co*	4^2	3	500	3.20	3990.35	.40	*Fe-V*	3^3	2	600	......
3947.66	.63	*Fe-Ti*	7^3	6	600	2.82	3991.16	.12	*Zr*$^+$*-Cr*	3	10	700	.75
3948.13	.11	*Fe*	5	2	600	3.23	3991.65	.65	*Co-Cr-*	3^3	4	500	0.58

† *Ti.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
3992.29	.30	$Fe\text{-}Ce^+$	3^2	3	400	......	4024.61	.66	$Fe\text{-}Ti$	7^2	8	750	3.23
3992.86	.83	$V\text{-}Cr$	3	2	400	2.70^2	4025.14	.14	Ti^+	3	10	750	0.60
3993.13	.10	Fe	2	1	400	......	4026.28	(.19)	He	....	30	5000	20.87
3993.80	.83	Ce^+	−1	2	400	......	4026.52	.48	$Ti\text{-}Mn$	3^2	3	500	2.11
3994.15	.12	Fe	4	3	400	2.83	4027.26	.32	$Zr\text{-}Cr$	1^2	2	400	0.62
3994.68	.60	$Nd^+\text{-}Co$	4^2	4	500	0.63^2	4027.95	.94	....	0	2	600	......
3995.31	.32	Co	5	6	600	.92	4028.36	.35	Ti^+	4	12	800	1.88
3995.76	.75	La^+	1	8	600	.17	4029.60	.65	$Zr^+\text{-}Fe$	5	6	500	0.71
3996.57	.62	$Sc\text{-}$	1^3	1	400	0.00	4030.48	.50	$Fe\text{-}Ti$	5	5	500	3.20
3996.96	.01	$V^+\text{-}Fe$	3^2	4	600	1.47	4030.79	.77	Mn	9	20	1000	0.00
3997.41	.43	$Fe\text{-}$	6^2	6	600	2.72	4031.26	.28	$Fe\text{-}Ce^+$	2^2	4	500	......
3997.97	.98	$Co\text{-}Fe$	8^2	4	600	1.04	4031.69	.72	La^+	2	6	600	0.32
3998.74	.71	$Zr^+\text{-}Ti\text{-}$	5^2	10	800	0.56	4031.92	.88	$Fe\text{-}Mn$	4^2	3	600	......
3999.21	.16	$Ce^+\text{-}$	1^2	10	800	......	4032.61	.58	Fe	6^2	5	750	1.48
4000.38	.36	Fe	4^2	6d	600	......	4033.07	.08	Mn	7	18	1000	0.00
4001.15	.17	$Mn\text{-}$	3	3	500	......	4033.68	.63	Mn	2	2	500	......
4001.65	.67	Fe	3	3	500	2.17	4034.47	.49	Mn	6	15	1000	0.00
4002.34	.30	$Ti\text{-}Fe$	3^4	1	400	2.11	4035.57	.61	V^+	2	4	750	1.78
4002.91	.94	V^+	2	4	500	1.42	4035.78	.74	Mn	4	6	750	2.13
4003.81	.77	$Ti\text{-}Fe\text{-}$	3	4	500	2.12	4036.82	.78	V^+	1	1	400	1.47
4004.95	.93	$Fe\text{-}$	3^3	2	500	......	4037.08	.12	....	2	1	400	......
4005.28	.26	Fe	7	7	1000	1.55	4037.65	.69	$Ce^+\text{-}Fe$	1	2	400	......
4005.74	.71	V^+	3	8	1000	1.81	4038.56	.60	$Fe\text{-}Mn$	4^4	1	400	......
4006.29	.32	Fe	2	2	400	......	4040.02	.05	$Fe\text{-}Y$	4^3	1	400	......
4006.73	.68	Fe	5^2	5	600	2.87	4040.62	.65	Fe	3	2	500	......
4007.34	.28	Fe	3	3	600	2.75	4040.82	.79	$Ce^+\text{-}Nd^+\text{-}$	1	12	700	......
4008.00	.96	$Ti\text{-}V^+\text{-}$	1^3	1	400	2.11	4041.38	.38	$Mn\text{-}Fe$	9^3	6d	600	2.10
4008.84	.91	$Ti\text{-}Fe$	5^2	7	600	0.02	4042.62	.60	Ce^+	0	4	600	......
4009.34	(.28)	He	....	2	1000	21.13	4042.87	.91	$La^+\text{-}Sa^+$	0	8	600	0.92
4009.73	.70	$Fe\text{-}Ti$	4^2	4	800	2.21	4043.98	.94	$Fe\text{-}$	5^2	4	500	2.72
4010.44	.49	$Fe\text{-}$	4^2	1	400	......	4044.64	.62	Fe	3	3	500	2.82
4011.19	.17	Fe	7^3	4d	400	2.55	4045.37	.39	Co	5	3	500	1.04
4011.96	.98	$Fe\text{-}Nd^+$	4^3	3	500	2.44	4045.84	.83	Fe	30	30	1800	1.48
4012.41	.39	$Ti^+\text{-}Ce^+$	4	20	1500	0.57	4047.34	.32	Fe	2	1	400	2.27
4013.62	.66	$Ti\text{-}Fe$	3	4	600	2.12	4047.89	.91	$Y\text{-}Sc$	2^3	2d	600	0.00
4013.86	.82	Fe	5	4	600	......	4048.65	.68	Zr^+	1	4	600	0.80
4014.53	.53	$Sc^+\text{-}Fe$	5	10	800	0.31	4048.80	.77	$Mn\text{-}Cr$	5	8	600	2.15
4014.94	.94	Ce^+	0	1	500	......	4049.46	.49	$Fe\text{-}Gd^+$	4^3	2d	500	2.58
4015.55	.56	$Ni^+\text{-}Ti$	4^3	3	500	4.02	4050.32	.33	Zr^+	0	3	500	0.71
4016.46	.43	Fe	2	2	400	......	4050.91	.85	$Fe\text{-}V\text{-}$	3^3	2	400	......
4017.19	.13	Fe	7^2	7	500	3.03	4052.10	.08	$Fe\text{-}Cr^+$	5^2	3	500	3.09^2
4017.60	.57	$Ti\text{-}Ni$	4^3	3	500	2.08	4052.48	.44	$Fe\text{-}Mn$	7^3	3	500	......
4018.28	.30	$Mn\text{-}Fe$	10^3	6	500	2.10	4053.32	.31	$Fe\text{-}Cr^+$	3^2	2	700	3.09^2
4019.04	.05	$Ce^+\text{-}Ni$	1	2	500	1.93^2	4053.84	.83	$Ti^+\text{-}Fe$	3	5	800	1.88
4019.32	.31	Co	0	1	400	0.58	4054.83	.85	Fe	5^2	5	500	3.38
4020.08	.14	$Mn\text{-}$	4^3	3	400	......	4055.08	.04	$Ti\text{-}Zr\text{-}*$	3	2	500	1.04
4020.44	.45	$Sc\text{-}Fe$	2^2	4	500	.00	4055.60	.55	Mn	6	5	500	2.13
4020.88	.92	Co	3	3	500	0.43	4056.16	.14	$Ti^+\text{-}Cr$	1^2	3	500	0.60
4021.50	.55	$Fe\text{-}Nd^+$	3^3	4	600	2.41	4056.55	.51	$Sc\text{-}Pr^+$	1^2	2	400	......
4021.91	.87	Fe	5	6	700	2.75	4057.20	.27	$Fe\text{-}Co\text{-}$	7^3	5	400	2.75
4023.42	.39	$V^+\text{-}Co$	3	6	750	1.80	4057.49	.52	Mg	7	5	600	4.33
4023.66	.69	Sc	2	6	750	0.02	4058.18	.23	$Co\text{-}Fe$	4	3	400	0.51
4024.06	.07	$Zr\text{-}Fe$	3^2	2	500	0.68	4058.93	.85	$Cr\text{-}Mn\text{-}*$	6^2	6	600	2.17^2

* *Fe.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4059.43	.38	*Mn*-	2^3	1	400	3.06	4094.90	.94	*Ca*	4	2	400	2.51
4059.74	.72	*Fe*	2	2	400	......	4095.37	.37	*Mn-V*	2^3	1	400	1.06^2
4060.32	.27	*Ti*	1	1	400	1.05	4096.02	.03	*Fe*	5^2	5	500	2.58
4061.06	.10	Nd^+-*Fe*	3	8	750	......	4097.06	.09	*Fe*	3	3	400	......
4061.90	.85	*Mn*-	4^2	2	400	3.06	4098.18	.18	*Fe-Cr*	5	5	500	3.23
4062.50	.45	*Fe*	5	5	600	2.83	4098.56	.56	*Ca*-	6^2	4	500	2.52
4063.26	.29	*Fe*	4	3	600	3.35	4098.83	.80	Gd^+	−2	1	500	......
4063.62	.61	*Fe*	20	20	1500	1.55	4099.83	.79	*V*	2	3	500	0.27
4064.30	.31	Cr^+-*Ti*-	5^4	2	500	3.09	4101.85	.85	*Hδ*	40	140	8000	10.16
4065.15	.09	*Ti-Mn*	2	1	500	1.05	4102.95	.94	*Si-Mn*	5	4	500	1.90
4065.45	.39	*Fe*	3	3	500	3.42	4103.50	.47	Dy^+-	1^3	2	400	......
4066.50	.48	*Co-Fe*	4^2	3	500	0.92	4104.12	.14	*Fe*-	5	5	450	3.25
4067.07	.10	*Fe*	8^2	6	700	2.82	4105.06	.09	*V-Fe*	3^2	6d	450	0.27
4067.43	.41	La^+	−2	1	700	0.17	4106.24	.27	*Fe*	2	2	450	......
4068.00	.99	*Fe*	6	3	450	3.20	4106.44	.43	*Fe*	2	2	450	3.38
4068.63	.66	*Co*-Ce^+	1^2	3	450	1.95	4107.49	.50	*Fe*	5	5	450	2.82
4069.20	.15	*Ti*-Nd^+	3^2	4	450	......	4108.54	.54	*Ca*-	2	2	400	2.70
4070.30	.28	*Mn-Fe*	3	3	400	2.18	4109.21	.16	*Fe*-Nd^+	4^2	4	600	......
4070.90	.85	*Fe*-Cr^+-	5^2	3	400	3.23	4109.73	.78	*V-Fe*	5^2	6	600	0.26
4071.75	.75	*Fe*	15	15	1500	1.60	4110.49	.54	*Co*	4	4	500	1.04
4072.36	.38	*Fe*-	3^3	1	400	3.42	4111.42	.36	*Cr*-Dy^+	1	1	450	2.89
4073.35	.36	Ce^+-Dy^+	1^2	3	500	......	4111.82	.79	*V*	4	5	450	0.30
4073.75	.77	*Fe*-Ce^+	4	4	500	3.25	4112.30	.32	*Fe*	2	2	400	......
4074.79	.81	*Fe*	5^2	5	500	3.03	4112.74	.72	*Ti*	1	1	400	0.05
4075.18	.20	Nd^+-Ce^+	3^3	2d	500	......	4113.09	.03	*Fe-Mn*	4^2	3	400	......
4076.07	.02	*Fe*-Ce^+	4^2	4	500	......	4113.85	.87	Nd^+-*Mn*	−1	3	450	......
4076.66	.66	*Fe*	8^3	5	500	3.20	4114.58	.62	*Fe*	6^2	3	450	2.82
4077.83	.73	Sr^+	8	80	6000	0.00	4115.20	.18	*V*	3	4	450	0.28
4078.47	.42	*Fe-Ti*	7^2	5	500	2.60	4116.63	.59	*V*-	3^3	3d	450	0.27
4079.16	.22	*Mn-Fe*	5^2	4	500	2.13	4117.87	.86	*Fe*-	2	1	500	......
4079.45	.42	*Mn*	3	3	500	2.18	4118.15	.16	Ce^+	0	3	500	......
4079.88	.85	*Fe*	3	3	500	2.85	4118.70	.70	*Fe-Co*	11^3	10	600	1.04^2
4080.30	.22	*Fe*-Nd^+	3	3	500	......	4119.38	.40	*Fe*	1	1	400	......
4081.22	.26	*Zr-Fe*	2^2	3	500	0.73	4119.78	.80	Ce^+-*Fe*	2^3	2	400	2.85^2
4082.23	.17	*Fe-Zr*	3^2	1	400	3.40	4120.30	.22	*Fe*	4	4	400	......
4082.44	.44	*Sc-Ti*-*	3	2	400	0.02	4120.78	(.81)	*He*	....	2	2500	20.87
4083.00	.95	*Mn-V*	4	4	400	2.17	4121.31	.33	*Co*	6	4	500	0.92
4083.58	.62	*Mn-Fe*	6^2	5	500	2.15	4121.87	.90	*Fe-Ti*-	4^2	3d	500	2.82
4083.82	.77	*V-Fe*	1	2	400	0.00	4122.60	.56	Fe^+-*Fe*	4^2	5d	600	2.57
4084.50	.50	*Fe*	5	4	400	3.32	4123.30	.24	La^+	2	7	700	0.32
4085.02	.02	*Fe-Cr*	4	3	400	2.83	4123.47	.47	*V*	2^2	2	500	.26
4085.30	.30	*Fe*-Ce^+	5^2	4	500	3.23	4123.78	.76	*Fe*	5	4	500	......
4086.30	.32	*Co*	3	3	400	1.87	4124.81	.85	Y^+-Ce^+	1^2	5d	600	0.41
4086.66	.72	La^+	1	8	500	0.00	4125.78	.75	*Fe*	7^3	4	500	......
4087.08	.10	*Fe*	3	2	400	......	4126.20	.19	*Fe*	4	3	400	3.32
4088.57	.57	*Fe*	3	3	450	......	4126.51	.52	*Cr*	2	2	400	2.53
4089.23	.23	*Fe*	3	2	400	......	4127.71	.71	*Fe*	8^2	7	600	2.85
4090.55	.56	Zr^+-*V*	2^2	2	800	1.54	4128.10	.10	*V*-	6	5	500	0.27
4090.97	.96	*Fe*-Ce^+	3	4	800	......	4128.76	.74	Fe^+	3^2	1	500	2.57
4091.54	.56	*Fe*	3	2	400	2.82	4129.26	.30	*Fe-Cr*	5^2	2	500	3.40
4092.39	.38	*Fe-Co*-	6^3	3	500	0.91	4129.73	.73	Eu^+	1	10	600	......
4092.62	.67	*V-Ca*	3	6	500	1.19	4130.68	.66	Ba^+	2	4	450	2.71
4094.36	.42	Gd^+-	2	1	400	......	4131.31	.36	*Cr*	0	1	400	......

* *Fe.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4131.91	.96	V	2	2	500	......
4132.13	.07	Fe	10	8	900	1.60
4132.91	.91	Fe	4	4	500	1.60
4133.78	.76	Fe-Ce$^+$	5^2	4d	500	3.35
4134.36	.39	Fe-V	6^2	6	500	0.00
4134.69	.69	Fe	5	6	500	2.82
4135.41	.38	Nd$^+$-	1^2	3	500	......
4135.84	.82	Zr-	1^2	2	400	0.63
4136.54	.53	Fe	4	3	500	......
4137.06	.01	Fe	6	5	500	......
4137.64	.66	Ce$^+$	1	5	500	......
4138.06	.07	Fe-V	1^2	1d	400	2.82
4139.89	.94	Fe	6	3	400	0.99
4140.36	.41	Fe	3	1	400	......
4141.66	.66	La$^+$	0	1	400	0.40
4141.88	.87	Fe	4	2	400	......
4142.41	.39	Cr-Ti-	8^4	2	400	......
4143.11	.06	Ti-Pr$^+$-	1^3	2	400	2.30
4143.90	(.77) .88	He Fe	 15	4 10	2000	21.13 1.55
4144.48	.52	Ce$^+$	0	1	450	......
4144.98	.01	Ce$^+$	0	2	450	......
4145.22	.20	Fe	1	1	400	2.68
4146.08	.07	Fe	3	4	400	......
4146.46	.43	Cr$^+$-Cr-	3^4	3	400	3.74
4147.40	.45	Mn-	3^2	3	400	......
4147.69	.69	Fe	4	3	400	1.48
4148.83	.80	Mn	0	1	400	......
4149.24	.20 .37	Zr$^+$ Fe	2 4	15d	900	0.80 ......
4149.88	.82	Fe-Ce$^+$	3^2	3	600	0.05
4150.25	.26	Fe	4	2	400	3.41
4150.53	.49	Ti-Co	2^2	2	400	2.29
4151.03	.97	Zr$^+$-Ti	1	4	600	0.80
4151.91	.96	La$^+$-Ce$^+$-*	2	4	500	.23
4152.18	.17	Fe-Sa$^+$	4^2	4	500	0.95
4152.53	.51	CN†	1^3	2	400	......
4153.36	.39	Fe	1	1	400	......
4153.94	.95	Fe-Cr	7^3	3d	500	3.38
4154.51	.51	Fe	4	4	500	2.82
4154.85	.82	Fe	4	4	500	3.35
4156.15	.19	Zr$^+$-Nd$^+$	5^4	12	500	......
4156.85	.81	Fe	3	5	500	2.82
4157.85	.79	Fe	5	5	400	3.40
4158.05	.01	CN‡	−1	2	400	......
4158.85	.80	Fe	5	3	400	3.41
4159.25	.19	....	5	2	400	......
4160.42	.43	Ti$^+$-Fe	3^2	1d	400	2.94^2
4161.08	.14	Zr$^+$-Fe	4^2	6	900	0.71
4161.50	.52	Ti$^+$-Fe	4	6	900	1.08
4162.64	.56	CN-	2^2	2d	600	......
4163.66	.66	Ti$^+$-Cr-*	4	15	1000	2.58

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4164.30	.28	V$^+$-CN	2^4	2d	400	2.03
4165.33	.37	Fe-CN	4^2	2	400	......
4165.58	.60	Ce$^+$	1	2	500	......
4166.01	.00	Ba$^+$	0	3	500	2.71
4166.85	.86	Ce$^+$-CN	0	1	500	......
4167.24	.28	Mg	8	4	800	4.33
4167.66	.65	Y-CN§	2^2	4	600	0.06
4167.94	.92	Fe	4^2	4	500	......
4168.76	.79	Fe	4^2	2	400	3.35
4169.05	(.97)	He	....	1	1000	21.13
4169.37	.41	Sa$^+$-CN	0^2	1	400	......
4169.81	.78	Fe	2	2	400	3.38
4170.87	.91	Fe	4	2	500	3.00
4171.10	.05	Ti-	4	2	500	2.14
4171.95	.91	Ti$^+$-Fe	2	15	1000	2.59
4172.16	.14	Fe	2	1	400	......
4172.68	.72	Fe-Cr$^+$	6^2	3d	600	0.95
4173.48	.46	Ti$^+$-Fe$^+$-*	8^3	15	1000	1.08
4173.95	.97	Fe-Ti$^+$	4^2	2d	500	0.99
4174.89	.90	Fe-Cr	5^2	3	500	0.91
4175.64	.64	Fe-Mn	5	5	500	2.83
4176.58	.58	Fe-Mn	5	3	400	3.35
4177.34	.34	Nd$^+$	0	1	500	......
4177.54	.58	Y$^+$-Fe	6^2	20	1000	0.30
4178.87	.86	Fe$^+$	3	15	1000	2.57
4179.42	.38	Cr$^+$-V	3	4	600	3.81
4180.36	.40	Fe-CN	1	2	400	2.72
4180.82	.81	CN‖	2	3	500	......
4181.81	.79	Fe-	8^3	7	700	2.82
4182.36	.39	Fe	3	3	500	3.00
4182.74	.76	Fe	2	1	400	......
4183.38	.42	V$^+$-Zr-¶	3^2	3d	400	2.04
4184.19	.16	Ti$^+$-Gd$^+$	6^2	4d	500	1.08
4184.89	.90	Fe-Cr	4	4	500	2.82
4186.56	.62	Ce$^+$-	2	3	900	......
4187.08	.05	Fe	6	4	900	2.44
4187.77	.77	Fe	10^4	8	900	2.42
4188.73	.74	....	4	2	400	......
4189.08	.04	CN	2^2	2	400	......
4189.52	.56	Pr$^+$-CN	2	2	400	......
4190.06	.06	Mn-Cr-	1^2	1	400	......
4191.48	.52	Fe	9^2	9d	800	2.46
4192.54	.57	Fe-CN	3^3	1	400	......
4192.95	.02	Ce$^+$-CN	0^2	2	400	......
4193.42	.37	Ce$^+$-CN	1^3	2	400	......
4194.44	.43	CN-Fe	1^4	0	400	2.72^2
4194.96	.90	Dy$^+$-CH	2^2	3d	450	......
4195.50	.44	Fe-Ni-	8^3	4d	450	3.32
4196.59	.55	La$^+$-Fe	2	6	500	0.32
4197.11	.10	CN^a	2	4	500	......
4198.14	.09	Fe-	3^2	1	500	......
4198.28	.29	Fe	8^2	6	800	2.39

* *Fe*. † Sixth head of second *CN* band. ‡ Fifth head of second *CN* band. § Fourth head of second *CN* band.
‖ Third head of second *CN* band. ¶ *Ti*. ^{a} Second head of second *CN* band.

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4198.69	.64	Fe-V	3	2	800	3.40	4235.21	.23	Mn	5^2	5	400	2.89
4199.09	.11	Fe	5	6	800	......	4235.92	.85	Fe-Y$^+$	10^3	10d	900	2.42
4199.94	.96	Fe-Ru	3^2	2d	500	0.09	4236.95	.95	Sa$^+$-CH	3^3	1	450	......
4200.53	.53	Ni-CH	2^2	3	500	3.29	4237.21	.20	Fe-	4^2	2	450	......
4200.85	.89	Fe-Ti	4^2	3	500	3.38	4237.99	.03	Fe-Sc	3	2	500	3.41
4201.65	.71	Fe-Ni	1	1	400	4.07^2	4238.39	.40	La$^+$	1	2	500	0.40
4202.11	.04	Fe	8	10	900	1.48	4238.86	.82	Fe	5	4	500	3.38
4202.43	.41	V$^+$-CN	1^2	2	400	1.70	4239.30	.37	Zr	2	0	400	......
4203.00	.07	Ce$^+$-Fe	4^3	4	500	......	4239.88	.82	Fe-Mn-	7^3	6	500	0.95
4203.59	.57	Cr-Fe	2	2	400	2.53	4240.40	.41	Fe-Ca	3^2	1	400	......
4203.98	.98	Fe-La$^+$	7^2	4	500	2.83	4240.68	.70	Cr	1	1	400	......
4204.68	.75	Y$^+$-CH	3^2	6	600	0.00	4241.10	.12	Fe-Pr$^+$	2	2	500	2.82
4205.06	.06	V$^+$-Eu$^+$	2^2	6	600	1.68	4242.24	.23	Cr$^+$-Er$^+$	1^2	1	500	......
4205.54	.55	Fe	2	2	450	3.40	4242.45	.43	Mn$^+$-CH	4^2	4	800	......
4206.69	.67	Fe-Sa$^+$	4^2	3d	450	0.05	4242.75	.74	Fe	2	2	400	......
4207.08	.13	Fe	3	3	450	2.82	4243.38	.38	Fe-CH	5^3	3d	500	......
4207.44	.41	Fe-CN	1	2	450	......	4243.87	.82	Fe	2	2	400	......
4208.59	.61	Fe	3	2	400	3.38	4244.66	.73	Sa$^+$-	−1	1	400	......
4208.95	.99	Zr$^+$	1	6	600	0.71	4245.28	.30	Fe	6^2	6	500	2.85
4209.71	.68	V-Cr	3^4	2	400	0.30	4246.06	.09	Fe	2	2	400	......
4210.37	.39	Fe-Sa$^+$	7^2	4d	500	2.47	4246.90	.84	Sc$^+$	5	50	5000	0.31
4211.00	.97	CH	3	1d	350	......	4247.41	.43	Fe	4	3	400	3.35
4211.89	.89	Zr$^+$	2	5	500	0.52	4248.26	.23	Fe	2	3	500	3.06
4212.73	.73	Cr-CN	4^2	1	400	......	4248.68	.73	Cr-CH	2	3	500	......
4213.65	.66	Fe-CH	3	3d	500	......	4249.52	.59	CH	3^2	1	400	......
4215.70	.54	Sr$^+$-CN	5	60	6000	0.00	4250.16	.13	Fe	8	9	900	2.46
4216.16	.14	Fe-CN*	4^2	2	400	0.00	4250.85	.81	Fe-	9^2	10	900	1.55
4217.15	.23	Gd$^+$-CH	2^2	3	500	......	4251.69	.69	Ti-Gd$^+$	1^2	2	500	2.30
4217.54	.57	Fe-La$^+$-	5	4	500	3.41	4252.46	.47	Cr$^+$-Nd$^+$-	2^3	4d	500	3.84
4218.36	.40	Zr	1	1	400	......	4252.96	.99	Mn$^+$-	3^3	1	400	......
4218.68	.73	CH	3	1	400	......	4253.39	.45	Ce$^+$-Gd$^+$	0^2	1	400	......
4219.40	.38	Fe	7^2	6	500	......	4254.36	.35	Cr	8	25	1500	0.00
4220.32	.35	Fe	3	4	450	......	4255.02	.98	Fe-CH	2	2	400	......
4220.62	.65	Y-Sa$^+$	−1	2	450	......	4255.50	.46	Fe-Cr-	3^3	3	500	......
4221.16	.17	Dy$^+$	−1	0d	450	......	4255.89	.84	Fe-CH	2	3	500	......
4222.22	.22	Fe	5	5	600	2.44	4256.44	.37	Sa$^+$-Dy$^+$	1^2	1	500	......
4222.70	.67	Ce$^+$-Cr	1^2	2	500	3.00^2	4257.65	.66	Mn	2	2	400	2.94
4223.18	.14	Pr$^+$-	2^2	2	500	......	4258.23	.24	Fe$^+$-Fe-	4^3	8d	500	2.69
4223.49	.53	CH-	2^2	0	400	......	4258.58	.62	Fe-CH	4^3	2	400	2.82
4224.19	.18	Fe	4	2	450	3.35	4259.07	.10	Fe-V-	4^4	3d	400	3.00
4224.65	.66	Fe-CH	5^2	3	400	3.41	4260.11	.08	Fe	5^2	3	500	3.06
4225.30	.37	Fe-V$^+$-	4^3	5	500	3.40	4260.51	.49	Fe	10	10	1000	2.39
4226.74	.74	Ca	20	40	5000	0.00	4261.42	.39	CH	4^2	3	600	......
4227.50	.44	Fe	4	3	400	3.32	4261.82	.85	CH-Cr$^+$	4^3	4	600	3.85^2
4227.72	.73	Ca$^+$-Zr-†	1^2	3	400	0.73^2	4263.19	.14	Ti-Cr	2	2	400	1.88
4228.68	.72	Fe	1	1	350	......	4263.62	.61	La$^+$	0	1	400	0.12
4229.71	.71	Fe-CH	6^3	3d	500	1.48	4264.32	.28	Fe-	4^2	2d	400	3.35
4231.03	.03	Ni-CH	4	3	400	3.53	4264.76	.74	Fe	2	1	400	3.94
4231.70	.65	Zr$^+$-Fe	2^2	1	400	1.75	4265.21	.27	Fe	2	1	400	3.91
4232.60	.65	Fe-Nd$^+$	3^2	2	400	0.11	4265.94	.93	Mn	2	1	400	2.93
4233.22	.17	Fe$^+$	4	30	2200	2.57	4266.82	.88	Fe-Cr	4^3	2	500	2.72
4233.66	.61	Fe	6	3	400	2.47	4267.40	.39	CH	2	0	400	......
4234.19	.23	V$^+$	0	0	400	1.68	4267.76	.81	Fe-	4^2	3	500	......

* First head of second *CN* band. † *Ti.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4268.67	.72	*Fe-V*	3^2	4d	500	......
4269.52	.48	La^+	0	1	400	......
4269.70	.74	*CH-V*	2	2	400	......
4270.19	.17	*Ti*-Ce^+	1	1	400	2.31
4271.16	.17	*Fe*	6	6	800	2.44
4271.77	.78	*Fe*	15	15	1500	1.48
4272.77	.73	*Cr-*	2^2	1	400	2.89
4273.36	.40	Fe^+-Zr^+-†	5^2	7	600	2.69
4273.99	.05	*CH-Fe*	4^3	2	400	......
4274.77	.75	*Cr-Ti*	9^2	20	1500	0.00
4275.55	.61	La^+-Cr^+	1^2	4	500	0.32
4276.64	.68	*Fe*	2	2	400	3.86
4276.99	.00	*V*	1	1	400	......
4277.46	.50	*Fe*-Zr^+-	3^2	2	400	2.60
4278.20	.22	*Fe*-Fe^+-†	4^2	4d	500	3.35
4278.76	.80	*Ti-Mn*	2^2	2	400	2.30
4279.65	.61	*CH-Fe*	4^2	3	450	3.87^2
4279.98	.04	Sc^+-*CH*	3^3	3	450	0.59
4280.41	.40	*Cr*	1	1	450	......
4280.72	.68	*CH*-Sa^+	2^4	2	450	......
4281.07	.10	*Mn*	2	2	450	2.91
4281.94	.97	*CH*	2	2	500	......
4282.46	.41	*Fe*	5	8	700	2.17
4282.96	.02	*Ca*	4	4	700	1.88
4284.14	.19	Cr^+-*V-*	3^2	3d	500	3.84
4284.81	.86	*Ti-Ni-*	4^3	2	400	1.73
4285.43	.46	*Fe*-Ce^+-	5^3	3	400	......
4285.98	.94	*Ti-Co-*	3^2	3	400	0.82
4286.43	.48	*Fe-CH*	3	2	400	2.94
4286.99	.96	La^+-*Fe*	3^2	2	400	3.93^2
4287.40	.41	*Ti*	1	1	400	0.83
4287.96	.01	Ti^+-*Ni*	4^3	6	700	1.08
4289.09	.04	*Ti-Fe*	3^2	2d	500	0.82
4289.60	.34	*Ca*	4	18	1500	1.87
	.73	*Cr*	5			0.00
4290.18	.23	Ti^+	2	18	2000	1.16
4290.95	.93	*Ti-Fe-*	4^2	4	500	0.81
4291.32	.28	*Fe-Ti-*	5^3	3	500	0.05
4292.09	.11	*Fe-CH*	6^4	5d	500	2.17
4293.03	.08	*CH*-Zr^+	5^2	5d	500	1.74^2
4294.07	.12	Ti^+-*Fe*	7^2	18	2000	1.08
4294.80	.78	Sc^+-*Zr*	2	3	500	0.60
4295.09	.13	*CH*	6^2	4	500	......
4295.91	.91	*Ti*-La^+-	4^3	5d	600	0.81
4296.67	.65	Fe^+-Zr^+-	4^3	9	600	2.69
4297.09	.13	*CH-Cr*	7^4	2	400	2.70^2
4298.10	.10	*Fe-CH*	4^2	3d	400	3.03
4298.72	.75	*Ti-Ni-*	4^2	2	550	0.82
4299.02	.00	*Ca*	3	3	550	1.88
4299.27	.25	*Fe-Ti*	4	3	550	2.42
4299.60	.65	*Ti*	2	2	550	0.82
4300.05	.06	Ti^+	3	25	2000	1.18
4300.61	.58	*Ti-CH*	2	2	500	0.82

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4301.08	.07	*Ti-CH*	6^2	3	500	0.83
4301.60	.62	*CH-*	1^2	0	400	......
4301.94	.93	Ti^+	2	8	1200	1.16
4302.59	.54	*Ca-CH*	8^3	5	900	1.89
4303.20	.18	Fe^+	2	4	900	2.69
4303.56	.51	Nd^+-	2^2	2	500	......
4303.95	.91	*CH-*	6^2	2	500	......
4304.49	.51	*CH-Fe*	3^2	2	450	2.94^2
4305.46	.46	Sr^+-*Fe-*	3	4	600	3.03
4305.82	.85	*Ti*-Sc^+	7^3	5	600	0.84
4306.73	.70	*CH*-Ce^+	2	3	500	......
4307.39	.44	*CH*	4^2	1	500	......
4307.86	.75	*Ca*	3	25	2000	1.88
	.91	Ti^+-*Fe*	6			1.16
4308.89	.85	*Fe-CH*	5^3	1	500	......
4309.35	.38	*Fe-CH*	3	2	500	2.94
4309.62	.63	Y^+-*CH*	1	5	800	0.18
4310.21	.24	*CH*	5^3	2	450	......
4310.76	.77	....	3^2	1	450	......
4311.12	.11	*CH*	3^2	1	450	......
4311.56	.56	*CH-Fe*	6^3	2	450	3.94^2
4312.12	.18	*CH*	5^3	2	450	......
4312.82	.88	Ti^+	3	12	1200	1.18
4314.08	.09	Sc^+	3	12	1200	0.62
4314.97	.02	Ti^+-*Fe-*	8^3	15	1200	1.16
4315.96	.96	La^+-Gd^+	−1	1	400	0.40
4316.75	.80	Ti^+	1	3	600	2.04
4317.20	.19	Zr^+-	1^2	2	500	0.71
4318.73	.66	*Ca-Ti*	4	7d	600	1.89
4319.55	.55	*Cr-Fe*	1^2	1d	400	2.88
4320.77	.84	Sc^+-Ti^+	5^2	25	1500	0.60
4321.60	.65	*Ti*	0	2	500	2.23
4322.42	.44	La^+	1^2	2	500	0.17
4323.20	.23	Sa^+-*CH*	2	4d	400	......
4323.73	.76	*CH-Cr*	4^2	2	400	......
4325.02	.00	Sc^+	4	8	1200	0.59
4325.79	.78	*Fe-Ni*	10^3	15	1500	1.60
4326.75	.76	*Fe*	2	2	450	2.94
4327.05	.11	*Fe*	3	3	450	......
4327.87	.92	*Fe*-Nd^+	2	3	450	......
4328.94	.94	Sa^+-*Fe*	1^3	3d	500	......
4330.09	.16	Ti^+-*V*	2^2	4	700	2.04
4330.66	.71	Ti^+	2	6	700	1.18
4331.66	.65	*Ni*-V^+	2	4	500	1.67
4332.80	.78	*V-Cr*	2^3	3d	500	0.02
4333.72	.76	La^+	1	10	600	0.17
4334.84	.81	La^+	2^3	2	500	......
4337.12	.06	*Fe*	5	4	500	1.55
4337.98	.93	Ti^+	4	15	2000	1.08
4338.77	.77	Nd^+-*Mn*	1^2	1	400	......
4340.63	.48	$H\gamma$	20	160	8000	10.16
4342.13	.19	Gd^+	0	1d	400	......
4343.20	.24	*Fe-Cr*	4^2	3	500	2.70^2

† *Ti*.

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4343.65	.71	*Fe*	2	2	500	......
4344.39	.44	*Ti*$^+$-*Cr*	6^2	6d	700	1.08
4346.70	.65	*Fe-Cr*	3^2	1	400	......
4347.39	.40	*Fe-Pr*$^+$	2^2	1	400	0.00
4347.90	.89	*Fe-Sa*$^+$	3^2	2	500	3.59
4348.94	.95	*Fe*	2	2	400	2.98
4349.76	.81	*Ce*$^+$	−1	1	400	......
4351.05	.00	*Cr-Ti*$^+$	4^2	3d	600	0.96
4351.84	.85	*Fe*$^+$-*Cr*-*	10^2	15	1200	2.69
4352.81	.77	*Fe-V*	5^2	6d	600	2.21
4354.18	.18	*La*$^+$-*Cr*	1^4	1	400	0.91
4354.74	.69	*Sc*$^+$-*Fe*	2^2	4	500	0.60
4355.08	.10	*Ca-Eu*$^+$	2	1	400	2.70
4356.00	.95	*Ni-CH*	1^2	2	350	3.62
4356.72	.75	*Mn-Co*	2^4	1	350	3.61^2
4358.13	.17	*Nd*$^+$	0	2d	500	......
4358.74	.72	*Y*$^+$-*Zr*	0	6	600	0.10
4359.65	.66	*Zr*$^+$-*Cr*	4^2	6d	600	1.23
4360.37	.39	*Ti-CH*	2^2	1	400	2.16
4360.86	.80	*Fe-Zr*	1	1	400	0.52^2
4361.99	.00	*Sa*$^+$	1^2	1	400	......
4362.56	.54	....	1	1	400	......
4363.18	.11	*Cr-CH*	1	2d	450	......
4364.19	.19	*Nd*$^+$-*Y*$^+$	1	2	450	3.96^2
4364.66	.67	*Ce*$^+$-*La*$^+$	−1	3	450	0.65^2
4365.84	.91	*Fe*	2	1	400	2.98
4366.56	.59	*CH*	2^2	3	400	......
4367.54	.59	*Fe*	5	3	400	2.98
4367.73	.68	*Ti*$^+$	2	4	600	2.58
4367.95	.95	*Fe-V*	3^2	2	400	1.60
4368.49	.47	*Nd*$^+$-*Ni*	1^2	1d	400	3.40^2
4369.39	.41	*Fe*$^+$	1	3	400	2.77
4369.72	.77	*Fe-Ti*	5^2	4	500	3.93
4371.01	.99	*Zr*$^+$	1	3	500	1.20
4371.28	.29	*Cr*	2	3	500	1.00
4371.58	.61	*Pr*$^+$-	1^2	0d	350	......
4372.26	.34	*Ti*	0	1	400	......
4373.57	.57	*Fe*	2	1d	400	2.55
4374.49	.47	*Sc*$^+$-*Fe*	3	10	1000	0.62
4375.00	.95	*Y*$^+$-*Mn*	2	12	1000	.41
4376.00	.95	*Fe*	6	8	800	0.00
4376.81	.78	*Fe-Cr*	1	1d	400	3.00
4377.24	.24	*CH*	2	2	400	......
4377.81	.80	*Fe*	1	1	350	......
4378.26	.26	*CH-Sa*$^+$	2	2	400	......
4379.25	.24	*V*	4	4	450	0.30
4379.76	.77	*Zr*$^+$-*Cr*	0	2	400	1.53
4380.71	.73	*CH*	2	2	400	......
4381.19	.16	*Cr-Mn*	1^2	0d	350	2.70
4382.16†	.17	*Ce*$^+$	−1	2d	450	......
4382.90	.84	*Fe-CH*	3^2	1	400	......
4383.54	.56	*Fe*	15	15	1600	1.48
4384.27	.32	*Ni*-	2^3	1	400	3.45
4384.69	.74	*V-Sc*$^+$	4^2	2	450	0.28
4385.14	.08	*Cr-La*$^+$-‡	4^3	2	400	1.03
4385.34	.39	*Fe*$^+$	2	5	600	2.77
4386.81	.86	*Ti*$^+$	1	4	450	2.59
4387.49	.50	*Cr-CH*	2^3	1	400	......
4387.86	(.93)	*He*	....	2	2000	21.13
4388.39	.42	*Fe*	3	2	400	3.59
4389.24	.26	*Fe*	2	1	400	0.05
4389.95	.99	*V*	2	2	400	0.27
4390.47	.49	*Fe*-	2^2	2	350	2.98
4390.96	.99	*Ti*$^+$-*Fe*	3^2	4	500	1.23
4391.67	.73	*Ce*$^+$-*Cr*	2^2	4	500	1.00
4393.01	.04	*V*	0	0	400	......
4394.01	.03	*Ti*$^+$-*Ti*	3^2	6d	500	1.22
4395.13	.13	*Ti*$^+$-*V*	5^2	40	2500	1.08
4395.89	.85	*Ti*$^+$	1	4	500	1.24
4397.18	.15	*Ni*	−1	0d	400	......
4398.00	.02	*Y*$^+$	1	4	750	0.13
4398.32	.31	*Ti*$^+$	0	5	750	1.22
4399.79	.78	*Ti*$^+$	3	10	800	1.23
4400.52	.46	*Sc*$^+$-*Ti*$^+$	4^2	9	800	0.60
4400.92	.86	*Nd*$^+$-*Ni*	0	0	350	3.64^2
4401.57	.55	*Ni*	2	4	400	3.18
4403.36	.38	*Zr*$^+$-*Cr*	0	3d	400	1.18
4404.27	.28	*Ti*	1	2	400	2.24
4404.79	.76	*Fe*	10	12	1200	1.55
4405.76	.74	*Pr*$^+$	0	1	350	......
4406.11	.16	*Fe-V*	0	0	350	......
4406.68	.65	*V*	2	2	400	0.30
4407.67	.69	*Fe-V*-§	6^2	3d	450	2.17
4408.18	.20	*V*	2	2	450	0.27
4408.46	.46	*Fe-V*	5^2	4	450	2.19
4408.75	.80	*Pr*$^+$	−1	0	400	......
4409.38	.40	*Ti*$^+$-*Sa*$^+$	2^3	3	400	1.23
4410.13	.12	*Cr*-	1^3	0	350	3.00
4410.53	.53	*Ni*	2	2	500	3.29
4411.08	.08	*Ti*$^+$-*Cr*	1	4	500	3.08
4411.84	.91	*Ti*$^+$-*Mn*	2^2	2	400	1.22
4412.15	.19	*V-Cr*	1^2	1	500	0.26
4413.10	.12	*Zr*$^+$	−1	0	350	......
4413.60	.68	*Cr*-	2^2	1	350	......
4414.12	.12	*Ti-Zr*	−1	0	350	......
4414.63	.55	*Zr*$^+$-*V*	−1	2	350	1.23
4415.12	.14	*Fe*	8	8	800	1.60
4415.53	.56	*Sc*$^+$	3	8	800	0.59
4416.43	.48	*V*	0	1	350	0.27
4416.84	.83	*Fe*$^+$	2	6	800	2.77
4417.22	.29	*Ti*	0	1	400	1.88
4417.71	.72	*Ti*$^+$	3	12	1200	1.16
4418.36	.34	*Ti*$^+$	1	2	400	1.23
4418.86	.95	*Gd*$^+$-*Ce*$^+$	1^3	1	350	......
4419.97	.94	*V*	−1	1	350	0.27
4420.54	.62	*Sc*$^+$-*Sa*$^+$	0^2	2d	400	0.62

* *Mg*. † Present in *a* Persei. ‡ *Fe*. § *Ti*.$^+$

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4421.25	.23	Sa$^+$-Co-	0^2	0	350	2.92^2	4453.72	.71	Ti	1	1	350	1.86
4421.61	.57	V	0	1	350	0.27	4454.41	.39	Fe	3	2	500	2.82
4421.91	.95	Ti$^+$	1	2	450	2.05	4454.77	.79	Ca-Zr$^+$	5	7	800	1.89
4422.61	.58	Y$^+$-Fe	3	4	500	0.10	4455.29	.32	Ti-Mn	2	2	400	1.44
4423.21	.18	Fe-Ti	2^2	1	350	2.98	4455.86	.87	Ca-Mn	5^2	3	500	1.89
4423.82	.85	Fe	2	1	350	......	4456.50	.34	Fe-Nd$^+$	1	2	350	3.03
4424.35	.35	Cr-Sa$^+$	1^2	3	400	3.00		.63	Ca-Ti$^+$	2	2	350	1.89
4425.35	.45	Ca	4	4	600	1.87	4457.04	.05	Mn	0	0	350	3.06
4426.12	.04	Ti-V	0	1	400	1.87	4457.50	.44	Zr$^+$-Ti	2	2	500	1.18
4427.05	.11	Ti	2	2	400	1.50		.55	Mn	2	2	500	3.06
4427.34	.32	Fe	5	8	800	0.05	4458.08	.16	Fe-Mn	4^2	2	350	3.87
4427.75	.75	La$^+$-Ti$^+$	0^3	1	350	......	4458.60	.53	Cr-Sa$^+$	0	1	350	3.00
4428.39	.46	V-Ce$^+$	1^2	1	350	0.27	4459.11	.10	Fe-Ni	5^2	5d	450	2.17
4429.17	.21	Ce$^+$-Pr$^+$	−1	2	350	......	4459.81	.76	V-Cr	1	0	350	0.28
4429.99	.99	La$^+$-Cr	0^2	5	450	0.23	4460.37	.30	Ce$^+$-V-‡	1^3	5	350	0.30^2
4430.57	.62	Fe	3	3	450	2.21	4461.12	.14	Zr$^+$-Fe-‡	2^2	2	350	1.01
4431.29	.29	Sc$^+$-Ni	1^3	2	350	0.60	4461.60	.66	Fe	4	5	700	0.09
4432.21	.14	Ti$^+$-Cr	0^2	1	350	1.23	4461.98	.00	Mn-Fe	3	2	350	3.06
4432.70	.63	Fe-	2^2	1	350	......	4462.52	.46	Ni	1	1	350	3.45
4433.21	.23	Fe	3	3	350	3.64	4463.02†	.06	Nd$^+$	0^2	2	350	......
4433.88	.86	Ti-Fe-	2^2	2	350	1.42	4463.51	.47	Ti-Ni	1^2	2	350	1.87
4434.32	.34	Sa$^+$-Ti	−1	1	350	......	4464.56	.57	Ti$^+$-Mn-	4^2	7d	700	1.16
4434.98	.02	Ca-Fe	7^2	7	800	1.88	4465.30	.36	Cr	0	0	350	3.00
4435.60	.69	Ca-Eu$^+$	4	5	600	1.88	4465.75	.81	Ti	1	1	350	1.73
4436.20	.28	Mn-V	3^2	1d	400	2.91	4466.59	.56	Fe	5	4	500	2.82
4436.93	.95	Fe-Ni	2	2	350	3.03	4466.93	.94	Fe	1	0	350	......
4437.70	(.55)	He	....	2d	750	21.13	4467.30	.34	Sa$^+$	−1	1	350	......
	.70	V	1^2			0.28	4468.48	.50	Ti$^+$	5	40	2500	1.13
4438.23	.23	Fe-Zr-	2^3	1	350	3.67	4469.37	.38	Fe	4	4	400	3.64
4439.84	.89	Fe	1	0	350	2.27	4469.60	.62	Co-V	1^2	2	350	2.94
4440.37	.43	Zr$^+$-Ti-*	1^2	3	350	1.20	4470.11	.14	Mn	1	0	350	2.93
4440.92	.88	Fe-Ce$^+$	2^2	1d	350	......	4470.47	.49	Ni	2	2	400	3.38
4441.74	.72	V-	3	4	350	0.27	4471.54	(.48)	He	....	80	7500	20.87
4442.33	.35	Fe	6	4	350	2.19	4472.88	.81	Fe$^+$-Fe-	2^3	6d	400	2.83
4443.03	.09	Zr$^+$-Fe	5^3	3	400	1.48	4474.05	.05	V	−1	0	350	......
4443.85	.81	Ti$^+$	5	30	2500	1.08	4474.74	.75	V	−1	0	350	......
4444.60	.56	Ti$^+$	2	4	450	1.11	4474.90	.87	Ti	0	1	350	1.44
4445.40	.48	Fe-	1	1	350	0.09	4476.04	.05	Fe	7^2	7	500	2.83
4445.69	.68	....	−1	0	350	......	4477.26	.27	Y-Pr$^+$	0^2	0d	350	1.35
4446.28†	.33	Nd$^+$-Fe	0^2	3	350	......	4477.97	.03	....	0	0	350	......
4446.86	.85	Fe	2	2	350	3.67	4478.73	.73	Gd$^+$-Sa$^+$	0^2	0	350	......
4447.19	.14	Fe-Mn	2	1	350	......	4479.56	.58	Fe-Mn-	2^3	2	350	3.67
4447.73	.73	Fe	6	5	450	2.21	4480.08	.09	Fe-	2^2	1	350	3.03
4449.18	.15	Ti	2	4d	400	1.88	4480.54	.59	Ni-Ti	0	0	350	3.88
4449.67	.72	Dy$^+$-	−1	0	350	......	4481.23	.24	Mg$^+$-Ti	2^2	4d	400	8.82
4450.37	.44	Ti$^+$-Fe	3^2	9	1000	1.08	4482.23	.21	Fe	8^2	8	500	0.11
4450.77	.76	Ce$^+$	−1	3	350	......	4482.71	.74	Ti-Fe	1	2	350	1.45
4450.98	.90	Ti	1	1	350	1.87	4483.87	.83	Ce$^+$-Cr	1^3	0	400	......
4451.55	.59	Mn-Nd$^+$	3	3	500	2.88	4484.25	.23	Fe	4	3	400	3.59
4452.01	.01	V	0	1	350	......	4485.66	.68	Fe	3	3	400	3.67
4452.76	.74	Sa$^+$	−1.	1	400	......	4486.92†	.91	Ce$^+$	0	4	450	......
4452.98	.01	Mn	1	1	400	2.93	4488.06	.11	Fe-Cr	2^2	1	400	3.59
4453.30	.32	Ti	2	1	350	1.42	4488.36	.33	Ti$^+$	1	4	450	3.11

* *Fe.* † Present in *α* Persei. ‡ *Mn.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4489.02	.07	*Ti-Fe-*	2^2	3	500	1.73	4526.46	.48	*Cr-Fe*	4^3	3	350	2.53
4489.19	.19	Fe^+	2	5	600	2.82	4526.94	.94	*Ca*	3	3	350	2.70
4489.73	.75	*Fe*	4	3	400	0.12	4527.33	.33	*Ti*-Ce^+	3	4	400	0.81
4490.10	.09	*Mn-Fe*	3	3	400	2.94	4528.60	.62	*Fe*-Ce^+	9^2	8	600	2.17
4490.67	.72	*Fe-Ni*	3^2	2d	400	3.93	4529.55	.53	Ti^+-*Fe*	2^2	6d	500	1.56
4491.46	.41	Fe^+	2	8	600	2.84	4530.92	.93	*Cr-Co*	4^3	4	500	2.53
4492.50	.50	*Cr-Ti*	1^2	1d	350	2.09^2	4531.17	.16	*Fe*	5	4	500	1.48
4493.51	.53	Ti^+-	1	2	400	1.08	4531.63	.63	*Fe*	2	2	400	3.01
4493.98	.02	*Fe*-Ce^+	2^2	1	400	3.97	4533.17	.16	*Ti-*	5^2	4d	400	0.84
4494.55	.58	*Fe*	6	4	600	2.19	4534.03	.00	Ti^+-Fe^+-	7^2	30	2500	1.23
4495.08	.14	*Ti-Cr*	0^2	0	350	......	4534.73	.79	*Ti*	4	3	400	0.83
4495.49	.50	Zr^+-*Fe*	1^2	1	350	1.20	4535.58	.61	*Ti-Cr*	4^2	4	400	.82
4496.16	.16	*Ti*	1	2	350	1.74	4535.99	.99	*Ti*	4^2	4	400	0.82
4496.88	.86	*Cr*	3	2	400	0.94	4536.55	.51	Sa^+	−1	0	350	......
4497.00	.98	Zr^+	0	3	400	0.71	4537.18	.22	*Ti*	−1	0	350	......
4497.95	.87	Ce^+-Nd^+	−2	1	350	......	4537.83	.78	*Fe*-Sa^+-	1^2	1d	350	......
4498.85	.90	*Mn*	1	1	350	2.93	4539.01	.01	*Fe-Ti*	2^5	0d	350	2.27
4499.15	.15	....	1	1	350	......	4539.80	.78	Ce^+-*Cr*	0	3	500	2.53
4499.47	.50	Sa^+-	−2	0	350	......	4540.61	.61	*Cr*	4^2	2d	500	2.53
4500.27	.29	*Cr*	0	1	350	......	4541.50	.50	Fe^+-*Cr*	3^2	6d	700	2.84
4501.28	.28	Ti^+	5	25	2500	1.11	4542.26	.34	*Fe-Zr*	2^2	1	350	0.63^2
4501.82	.78	*Cr*	0	0	350	......	4542.71	.67	*Fe-Cr*	1^2	1	350	3.67
4502.29	.23	*Mn*	2	1	350	2.91	4543.80	.83	*Co*	0	1	400	2.71
4503.82	.82	*Mn-Ti*	0^2	0	350	2.12^2	4544.03	.02	Ti^+	1	4	500	1.24
4504.84	.84	*Fe*	1	1	350	3.25	4544.68	.68	*Ti-Cr*	4^2	4	500	0.82
4505.40	.36	*Ti-*	1^3	0d	350	2.09	4545.12	.14	Ti^+	1	4	500	1.13
4506.35	.33	*Ti-*	−1	0	350	......	4545.96	.96	*Cr*	3	4	500	0.94
4506.76	.74	Ti^+-	1^3	2d	350	1.13	4547.04	.99	*Fe-Ni*	4^3	3d	400	1.55
4507.30	.23	Cr^+	−1	0	350	3.09	4547.86	.86	*Fe*	3	3	400	......
4508.32	.29	Fe^+	4	12	900	2.84	4548.84	.78	*Ti*	2	2	400	0.82
4509.30	.29	*V*	0	0	350	......	4549.63	.60	Ti^+-Fe^+	8^2	50	2500	1.58
4509.87	.83	*Fe*	1^2	1	350	......	4550.70	.78	*Fe*	2	1	350	......
4511.10	.12	*Ti-*	1^2	1d	350	....	4551.17	.23	*Ni*	0	0	350	4.15
4511.84	.90	Sa^+-*Cr*	1	2	400	......	4552.46	.46	*Ti-*	2	5d	400	0.83
4512.74	.75	*Ti*	3	2	450	0.83	4553.00	.05	*V-Zr*	−1	0	350	......
4513.05	.00	*Ni*	0	0	350	3.69	4554.11	.04	Ba^+	8	50	2000	0.00
4514.40	.35	*Fe-V-*	3^3	2d	350	......	4554.95	.99	Cr^+	2	1d	350	4.05
4515.32	.34	Fe^+	3	10	800	2.83	4555.52	.49	*Ti*	3	2	350	0.84
4516.29	.27	Nd^+	0	1	350	......	4555.89	.89	Fe^+	3	20	1000	2.82
4517.56	.54	*Fe*	3	2	350	3.06	4557.30	.29	....	0	0d	300	......
4518.04	.03	*Ti*	3	2	400	0.82	4558.57	.62	Cr^+-La^+	3^2	15d	1500	4.06
4518.31*	.34	....	1	2	400	......	4560.09	.10	*Fe*	2	2	350	3.59
4518.69	.65	*Ti-*	1^2	0	350	1.42	4560.33	.35	Ce^+-Sa^+	0^2	2	450	......
4519.58	.64	Sa^+	−1	2	350	......	4560.85	.86	*V*-Ce^+	0^3	1	350	......
4520.22	.23	Fe^+	3	12	800	2.80	4561.42	.42	....	1	0	350	......
4521.18	.14	*Cr*	0	1	400	......	4562.30†	.37	Ce^+	0	4	500	......
4522.34	.38	La^+	−1	2	400	0.00	4563.76	.77	Ti^+	4	30	2500	1.22
4522.67	.68	Fe^+-*Ti*	5^2	18	1000	2.83	4564.62	.66	V^+-*Fe-*	1^2	1d	350	...
4523.07	.09	Ce^+-Sa^+	0	2	450	......	4565.50	.52	*Cr*	3	3	400	0.98
4523.89	.93	Sa^+	−1	2	400	......	4565.72	.67	*Co-Fe*	2	2	400	3.00
4524.65	.69	Ti^+-*Co*	0	2	400	1.23	4566.67	.70	*Fe*	2^2	0	350	......
4525.15	.12	*Fe*-Ba^+	6^2	5	400	3.59	4568.35	.30	Ti^+	0	2	350	1.22
4526.10	.10	La^+-*Cr*	0	1	350	0.77	4568.85	.80	*Fe*	2^2	1	350	3.25

* Strongly enhanced in α Persei. † Present in α Persei.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4569.39	.44	*Cr*	0^2	1	350	......	4611.29	.30	*Fe*	5	5d	450	3.64
4569.80	.75	*Cr-La*$^+$	1^2	0	350	......	4613.24	.22	*Fe*	3	2	400	3.28
4571.08	.10	*Mg*	5	6	700	0.00	4613.42	.37	*Cr-La*$^+$	3	5	450	0.96
4572.00	.98	*Ti*$^+$	6	35	2500	1.56	4613.93	.92	*Zr*$^+$	1	2	400	0.97
4574.24	.23	*Fe*	1	0	350	3.20	4615.57	.57	*Fe-Sa*$^+$	1	2d	400	......
4574.74	.76	*Fe-La*$^+$	2^2	3	400	2.27	4616.09	.13	*Cr*	4	5	500	0.98
4576.32	.34	*Fe*$^+$	2	8	500	2.83	4616.63	.63	*Cr*$^+$	1	2	500	4.06
4577.20	.19	*V*	0	2	350	0.00	4617.30	.28	*Ti*	3	3	400	1.74
4577.68*	.74	*Sa*$^+$-*Dy*$^+$	0^2	2	350	......	4618.81	.79	*Cr*$^+$-*Fe*	4	6	800	4.06
4578.54	.56	*Ca*	3	2	350	2.51	4619.30	.30	*Fe*	3	2	400	3.59
4578.80	.75	*V*	−1	0	350	......	4619.70	.63	*Cr-V*	2^2	1	350	......
4579.24	.29	*Fe-Nd*$^+$	1^2	1	350	2.82	4620.55	.52	*Fe*$^+$	1	7	500	2.82
4579.99	.06	*Cr-La*$^+$	3	4	400	0.94	4621.50	.48	*Cr*$^+$	−1	1	350	3.70
4580.42	.42	*V-Ti*$^+$	1	2	400	0.02	4621.91	.93	*Cr*	2^2	2d	400	......
4581.42	.46	*Ca-Fe*	8^2	6d	400	2.51	4622.40	.45	*Cr*	1	1	400	......
4582.32	.38	*Zr-Ce*$^+$	1^2	1	400	......	4623.10	.10	*Ti*	2	3	400	1.73
4582.86	.84	*Fe*$^+$	1	4	450	2.83	4624.40	.42	*V*	−1	0	350	1.05
4583.40	.42	*Ti*$^+$	0	1	450	1.16	4625.03	.05	*Fe*	5	4	400	3.23
4583.86	.84	*Fe*$^+$	4	25	1500	2.80	4626.21	.18	*Cr*	5	3	400	0.96
4584.76	.80	*Fe-Sa*$^+$	3^2	2d	350	3.59	4626.60	.54	*Mn*	0	1	350	......
4585.91	.88	*Ca*	4	3	400	2.52	4627.44	.46	*Eu*$^+$-	1^2	1d	350	......
4586.31	.30	*V-Cr*	2^2	3	400	0.04	4628.16	.17	*Ce*$^+$-*Cr*	1^2	4	400	......
4587.11	.14	*Fe*	2	1	400	......	4629.42	.35	*Fe*$^+$-*Ti*-	6	20	1000	2.80
4588.20	.21	*Cr*$^+$	3	8	1000	4.05	4630.14	.13	*Fe*	4	2	350	2.27
4589.93	.96	*Ti*$^+$	3	10	1000	1.23	4632.18	.15	*Cr*	0	0	350	......
4591.22	.25	*V*	−1	0	350	......	4632.85	.90	*Fe*-	5^2	3	400	1.60
4591.39	.40	*Cr*	2	2	400	0.96	4633.26	.26	*Cr*	0	0	350	3.11
4591.96	.00	*Cr*$^+$-*Sa*$^+$	2^2	2d	400	4.06	4634.04	.08	*Cr*$^+$	2	6	800	4.06
4592.50	.53	*Ni*	2	3	400	3.53	4635.35	.32	*Fe*$^+$	0	1	350	......
4592.70	.66	*Fe*	4	3	400	1.55	4635.83	.86	*Fe*	2	2	350	......
4593.53	.53	*Fe*	1	0	350	......	4636.31	.33	*Ti*$^+$	0	2	350	1.16
4593.99	.03	*V-Ce*$^+$	4^3	4d	400	0.07	4637.14	.18	*Cr*	0	0	350	......
4595.28	.37	*Fe-Sa*$^+$	2	2	400	......	4637.49	.51	*Fe*	5	4	400	3.27
4595.87	.93	*Fe-Fe*$^+$-†	3^3	2d	400	3.59	4638.02	.02	*Fe*	4	3	400	3.59
4596.99	.95	*Co-Nd*$^+$-	1^2	1d	350	3.62	4639.51	.51	*Ti-Cr*	5^3	3d	400	1.73
4597.75	.82	*Gd*$^+$-	2^2	2	400	......	4640.16	.12	*Ti-V*	2^2	2d	400	1.73
4598.14	.13	*Fe*	3	2	350	3.27	4641.14	.14	....	1^2	1d	350	......
4598.75	.75	*Fe*	0	0d	350	......	4642.31‖	.25	*Sa*$^+$	−1	3d	400	......
4599.67	.74	*Fe-Ti*	2^2	0d	350	......	4643.41	.47	*Fe*	4	3	400	3.64
4600.17	.14	*V*$^+$-*Cr*	1^2	2	500	......	4644.19	.22	*Ce*$^+$-*Sa*$^+$	1^3	1d	350	......
4600.74	.76	*Cr*	3	2	400	1.00	4645.31	.35	*Ti-La*$^+$	1^3	1	350	1.73
4601.16	.11	*Cr-Gd*$^+$	1^2	1	400	......	4646.16	.17	*Cr*	5	8	600	1.03
4602.03	.01	*Fe*	3	2	400	1.60	4646.72	.69	*Cr*-	2^2	1	350	3.09
4602.95	.95	*Fe*	6	4	600	1.48	4647.45	.44	*Fe*	4	4	500	2.94
4604.53	.56	*Fe*	2	1	350	......	4648.05	.02	*Cr*	2^2	0	350	......
4604.96	.00	*Ni*	3	3	400	3.46	4648.86	.79	*Ni-Cr*	5^3	4d	500	3.40
4605.66‡	.60	....	2	0	350	......	4649.45	.44	*Cr*	0	0	350	......
4606.29	.28	*Ni-Ce*$^+$	3^2	2d	400	3.58	4650.03	.02	*Ti*	0	0	350	1.73
4607.31	.34	*Sr*	1	2	400	0.00	4651.29	.29	*Cr*	4	4	400	0.98
4607.67	.66	*Fe*	4	2	400	3.25	4652.16	.17	*Cr*	5	4	450	1.00
4609.26§	.27	....	0	0	350	......	4653.42	.44	*Fe-Ti*	0^2	1	400	0.99
4609.92	.91	*Cr*-	0	0	350	......	4654.11	.16	*Cr-Ce*$^+$	0	0	350	......

* Present in α Persei. † *Cr*. ‡ Intensity = 2 in α Persei. § Enhanced in α Persei.
‖ Present in γ Cygni and α Persei.

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4654.64	.57	*Fe*	9^2	6d	400	3.20	4701.93	.91	*Fe*	0	0	300	3.42
4655.73	.73	*La*$^+$-*Ni*-†	1^3	2d	350	3.68^2	4702.99	.00	*Mg*	10	6	500	4.33
4656.44	.47	*Ti*	3	2	350	0.00	4703.76	.82	*Ni*	3	2	400	3.64
4657.10	.14	*Ti*$^+$-*Fe*$^+$	3^2	6d	400	1.24	4704.36	.41	*Sa*$^+$	1^3	1d	350	......
4660.19	.23	....	1^4	0d	350	......	4704.93	.96	*Fe*	4	2	350	......
4661.97	.98	*Fe*-*Eu*$^+$	1	0	350	2.98	4705.45	.48	*Fe*	1	0	300	......
4662.77	.82	*La*$^+$-*Fe*	2^3	1	350	0.00	4706.52	.56	*Nd*$^+$-*V*	0	2	350	......
4663.35	.35	*Cr*-*Co*	2^2	3	350	3.09	4707.31	.35	*Fe*	7^2	4d	400	3.23
4663.82	.79	*Fe*$^+$-*Cr*	2^2	3	400	2.88	4708.00	.02	*Cr*	2	1	450	3.15
4664.83	.80	*Cr*	3	1	350	3.11	4708.63	.67	*Ti*$^+$	2	4	500	1.23
4666.09	.06	*Cr*	2^2	1d	350	......	4708.93	.98	*Fe*-*Ti*	1	1	350	2.15^2
4666.74	.72	*Fe*$^+$-*Cr*-‡	4^4	8d	400	2.82	4709.15	.10	*Fe*	3	1	350	3.64
4667.61	.55	*Fe*-*Ti*-‡	8^3	5	400	0.02^2	4709.71	.72	*Mn*	2	2	350	2.88
4668.13	.13	*Fe*-	6^2	3d	400	3.25	4710.24	.29	*Fe*	3	3	350	3.00
4669.25	.21	*Fe*-*Cr*	4^2	3	400	3.64	4711.50	.49	*Fe*	0	1	350	......
4669.58	.53	*Sa*$^+$-*Ce*$^+$	0^3	2	400	......	4712.09	.08	*Fe*-*Ni*	0	0	350	3.64^2
4670.38	.42	*Sc*$^+$	2	8	600	1.35	4713.15	(.14)	*He*	....	5	5000	20.87
4671.40*	.42	....	1	0	350	......	4713.99	.04	*Fe*-*Ce*$^+$	1^3	1	350	......
4672.34*	.34	....	3	1	350	......	4714.40	.42	*Ni*	6	8	500	3.36
4673.15	.17	*Fe*	4	2	350	......	4714.96*	.91	*Cr*$^+$-C_2	−2	2	350	......
4674.13*	.14	....	2^2	0	350	......	4715.80	.77	*Ni*	4	4	400	3.53
4674.65	.66	*Fe*-*Sa*$^+$	0	2	350	1.55	4716.82	.84	....	−1	0	300	......
4676.86	.93	*Sa*$^+$-*Ti*	−1	1	350	2.50^2	4717.56	.54	*V*-*Sa*$^+$	1^3	1d	300	......
4677.42	.43	*Ti*	−1	0	300	3.05	4718.43	.42	*Cr*	3	3	400	3.12
4678.82	.86	*Fe*	6	3	400	3.59	4719.52	.51	*Ti*$^+$	0	2d	350	1.24
4679.20	.23	*Fe*	2	1	400	3.35	4721.02	.00	*Fe*	2	2	300	2.98
4680.14	.14	*Zn*-*Ce*$^+$	1	3	400	3.99	4722.16	.16	*Zn*	3	4	400	4.01
4680.72	.72	*Cr*-*Nd*$^+$	1^2	2	350	2.70	4723.30	.23	*Ti*-	0^2	2d	300	1.05
4681.46	.48	*Fe*	1	0	350	......	4724.36*	.41	*Nd*$^+$-*La*$^+$-	0	3	300	......
4681.95	.92	*Ti*	3	3	400	0.05	4726.13	.15	*Fe*	0	0	300	2.98
4682.41	.35	*Y*$^+$-*Co*	1	3	400	0.41	4727.44	.44	*Fe*-*Mn*	5^2	5d	400	3.67
4683.53	.57	*Fe*	3	2	400	2.82	4728.15	.17	....	0	0	300	......
4684.25	.29	....	0^2	1	350	......	4728.57	.55	*Fe*	4	3	350	3.64
4684.60	.60	*Ce*$^+$-*Cr*	0	1	350	......	4729.42	.36	*Fe*-*Cr*	2^2	1d	300	3.38
4685.22	.22	*Ca*-*Ti*	3^2	2	350	2.92	4730.04	.04	....	2	2	300	......
4685.83	(.81)	*He*$^+$	....	2N	3500	48.16	4730.87	.82	*Cr*-	2^2	2	350	......
4686.17	.22	*Ni*	3	2	350	3.58	4731.48	.48	*Fe*$^+$	4	7	500	2.88
4687.33	.34	*Fe*-*Sa*$^+$	3^3	2d	350	0.95	4731.76	.81	*Ni*	1	1	350	3.82
4687.77	.81	*Zr*	0	0	300	.73	4732.46	.47	*Ni*	1	1	300	4.09
4688.55	.54	*Zr*-*Ti*	1^2	1	350	0.15	4733.61	.60	*Fe*	4	4	400	1.48
4689.33	.36	*Cr*	2	2	350	3.11	4734.08	.11	*Fe*	1	1	350	......
4690.14	.15	*Fe*	4	2	350	3.67	4735.86	.85	*Fe*	3	2	350	......
4691.51	.44	*Fe*-*Ti*	7^3	4d	450	2.98	4736.79	.78	*Fe*	6	6	500	3.20
4692.58	.53	*La*$^+$-	1^3	1	350	......	4737.33	.36	*Cr*	2	2	350	......
4693.80	.86	*Cr*-*Ti*	2^2	0	300	0.02^2	4737.64	.64	*Fe*-*Sc*	1	1	350	1.43^2
4694.81	.87	*Fe*	1	0	300	......	4739.12	.12	*Mn*	3	2	350	2.93
4695.27	.30	*Cr*-	1^2	1	300	......	4739.52	.45	*Zr*-*Ce*$^+$	−1	1	300	0.65
4697.23	.17	*Cr*	2^2	2d	300	2.70	4740.19	(.25)	*La*$^+$	....	2	350	0.12
4698.66	.62	*Cr*-*Ti*	3^3	5d	350	2.70	4740.37	.42	*Fe*-	2^2	2	350	3.00
4699.35	.34	....	4	2	350	......	4741.00	.02	*Fe*-	2^2	1	350	3.32
4700.16	.16	*Fe*	4	2	350	......	4741.56	.54	*Fe*	3	2	350	2.82
4701.09	.06	*Fe*	1	1	300	3.67	4742.75	.80	*Ti*	1	1	300	2.23
4701.52	.54	*Ni*	1	1	300	4.07	4743.05	.11	*La*$^+$	−2	1	350	......

* Present in α Persei. † *Ti*. ‡ *Ni*.

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4744.38	.39	*Fe*	3	2	350	......
4745.75	.81	*Fe*	4	3	350	3.64
4748.18	.14	....	4	3	300	......
4748.76	.74	La^+	−2	1	300	......
4749.78	.85	*Fe-Co*	2^2	2d	350	3.04^2
4751.11	.10	*Fe*	1	1	300	......
4752.02	.11	*Cr-Ni*	2	1	300	3.66^2
4752.42	.43	*Ni*	3	3	350	3.64
4753.99	.04	*Mn*	7	5	400	2.27
4754.74	.77	*Ni-Cr*	1	1	300	3.62
4756.07	.12	*Cr-Fe*	2	2	350	......
4756.49	.52	*Ni*	3	3	350	3.46
4757.55	.59	*Fe*	2	2	350	......
4758.11	.13	*Ti*	1	2	350	2.24
4759.32	.28	*Ti*	2	2	350	2.25
4760.08	.08	....	−1	0	300	......
4761.56	.53	*Mn*	3	3	350	2.94
4762.49	.44	*Mn-Ni*	6^2	4	400	2.88
4762.86	.78	Ti^+-*Zr*	0	1	400	1.08
4763.98	.92	Ti^+-*Ni*	4	6	400	3.64^2
4764.52	.53	Ti^+	0	3	350	......
4765.46	.47	*Fe*	2	3	350	1.60
4765.89	.87	*Mn*	3	3	350	2.93
4766.38	.43	*Mn*	4	4	350	2.91
4768.32	.37	*Fe-*	5^2	3d	350	2.93
4769.79	.80	*Ti*	−1	1	300	2.25
4771.13	.09	*Ti-Co*	−1	1	300	0.82
4771.60	.57	*Fe-*	5^2	3d	350	2.19
4772.79	.82	*Fe*	4	2	350	1.55
4773.39	.42	*Ni*	−1	0	300	3.69
4773.99	.97	Ce^+	−2	0	300	......
4776.11	.07	*Fe*	−1	0	300	......
4776.40	.36	*V-Co-**	0	2	350	2.05
4779.41	.45	*Fe*	1	1	300	......
4779.97	.99	Ti^+-*Co*	2	10	500	2.04
4781.48	.46	*Co-*	−2	1d	300	1.87
4783.47	.43	*Mn*	6	8	500	2.29
4783.97	.00	Ce^+	0	1	300	......
4786.00	.96	*Fe*	0	0	300	......
4786.50	.54	Y^+-*Ni*	3	10	450	1.03
4786.86	.82	*Fe*	1	1	400	3.00
4787.90	.84	*Fe*	1	1d	350	2.98
4788.74	.77	*Fe*	3	2	350	......
4789.31	.34	*Cr*	2	4	400	2.53
4789.63	.66	*Fe*	3	4	400	......
4791.15	.22	*Fe-*	2^2	2d	350	......
4792.49	.52	*Ti-Cr*	2	3	400	2.32
4792.94	.86	*Co*	1	2	400	3.24
4794.38	.37	*Fe*	−1	0	300	2.41
4796.24	.19	*Cr-Ti*	−1	0	300	2.32^2
4798.29	.27	*Fe*	1	1	300	......
4798.62	.64	Ti^+-*Fe*	2^2	4	400	1.08
4799.46	.42	*Fe*-Nd^+	1	1	300	......

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4799.80	.80	*Ti-V*	1	1	300	2.26
4800.64	.66	*Fe*	2	2	350	......
4801.04	.03	*Cr-Fe*	1	1	350	4.27^2
4802.86	.89	*Fe*	2	2d	300	......
4805.13	.10	Ti^+	3	15	800	2.05
4807.06	.00	*Ni*	2	2	300	3.66
4807.75	.72	*Fe*	1	0	300	3.35
4808.50	.45	*Fe-Ti*	1^3	1	300	3.05^2
4809.06	.02	*Fe-Ni*	0^2	0	300	3.69^2
4810.45	.54	*Zn*	3	5	400	4.06
4811.24	.16	*Ti*-Nd^+	0^2	0d	300	1.88
4812.18	.24	Cr^+-*Ni-*	1^2	1	300	3.85
4813.10	.12	*Fe*	0	0	300	......
4813.48	.48	*Co-*	1	3	350	3.20
4814.56	.60	*Ni*	−1	0	300	3.58
4815.74	.74	*Zr*-Sa^+	-1^2	2d	300	0.60
4817.75	.81	*Fe-Ni*	2	2	400	2.21
4820.39	.42	*Ti*-Nd^+	1	3	350	1.50
4821.10	.13	*Ni-*	0	0	300	4.14
4823.46	.52	*Mn*-Y^+	5	10	750	2.31
4824.09	.14	Cr^+-*Fe*	3	12	750	3.85
4825.47†	.48	Nd^+-*Ti*	0^3	8	500	2.31^2
4827.50	.54	*V-Ti*	0^2	1d	300	0.04
4829.00	.03	*Ni*	3	5	400	3.53
4829.40	.37	*Cr*	2	2	350	2.53
4831.13	.18	*Ni*	3	3	400	3.59
4831.70	.65	*V*	−1	0	300	0.02
4832.40	.43	*V*	−1	0	300	0.00
4832.76	.72	*Fe-Ni*	3	2	350	4.28
4834.56	.52	*Fe*	1	1	300	2.41
4835.84	.88	*Fe*	2	3	400	4.09
4836.28	.24	Cr^+	0	2	400	3.84
4838.54	.57	*Fe-Ni*	3^2	3	350	3.40
4839.55	.55	*Fe*	3	2	300	......
4840.24	.30	*Fe-Co*	5^2	5	350	4.14
4840.83	.89	*Ti*	3	2	300	0.90
4842.83	.80	*Fe*	1	1	300	4.09
4843.21	.15	*Fe-Ni*	3	2	300	3.38
4844.09	.02	*Fe*	1	1	350	......
4845.66	.06	*Fe*	1	0	300	......
4848.30	.25	Cr^+	2	6	400	3.85
4848.87	.89	*Fe*	1	1	300	2.27
4849.15†	.17	....	0	3	300	......
4851.49	.50	*V*	1	2	350	0.00
4852.59	.56	*Ni*	2	1	300	3.53
4854.82	.88	Y^+	1	8	500	0.99
4855.37	.42	*Ni*	3	2	300	3.53
4855.70	.68	*Fe*	2	2	300	3.35
4856.00	.02	*Ti*	1	0	300	2.25
4857.33	.40	*Ni*	1	2d	350	3.72
4859.03	.11	*Fe*-Nd^+	1^2	1	350	4.17
4859.77	.75	*Fe*	4	2	350	2.86
4861.50	.35	$H\beta$	30	200	8500	10.16

* *Fe*. † Strongly enhanced in α Persei.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4863.65	.65	*Fe*	2	1	350	3.42	4919.02	.00	*Fe*	6	6	400	2.85
4864.32	.32	Cr^+	1	3	350	3.84	4919.84	.87	*Ti*	−1	1	300	2.15
4864.71	.74	*V*	0	1	300	0.02	4920.50	.52	*Fe*	10	10	500	2.82
4865.52	.62	Ti^+	1	2	350	1.11	4920.92	.96	La^+	0	3	400	0.12
4866.35	.28	*Ni*	2	1	300	3.52	4921.80	.79	La^+-*Ti*	1	4	400	0.24
4868.02	.00	*Co-Ti*	2^2	2d	350	3.10	4922.01	.93	*He*	....	3	2500	21.13
4870.19	.14	*Ti*	1	0	300	2.24	4923.09	.15	*Fe*	0	0	300	......
4870.80	.82	*Cr-Ni*	3	0	350	3.73^2	4923.96	(93)	Fe^+	5	30	2000	2.88
4871.36	.33	*Fe*	5	6	500	2.85	4924.83	.78	*Fe*	3	1	350	2.27
4872.17	.15	*Fe*	4	5	500	2.87	4925.32	.28	*Fe*	−1	0	300	......
4873.45	.45	*Ni*	2	2	400	3.68	4925.60	.58	*Ni*	1	1	350	3.64
4873.98	.02	Ti^+	0	3	400	3.08	4927.35	.43	*Fe*	1	0	300	......
4875.51	.49	*V*	1	1	350	0.04	4927.87	.87	*Fe*	2	2	350	......
4875.93	.88	*Fe*	2	1	350	3.32	4928.37	.34	*Ti*	0	1	350	2.14
4876.41	.41	Cr^+	1	5	350	3.84	4930.37	.31	*Fe*	2	2	350	3.94
4878.18	.19	*Fe-Ca*	7^2	7d	500	2.87	4930.81	.80	*Ni*	−1	0	300	3.83
4881.57	.56	*V*	1	1	350	0.07	4932.02	.07	*Ni*	0	0d	300	......
4881.75	.73	*Fe*	2	2	350	......	4933.31	.34	*Fe*	2	2	350	......
4882.18	.15	*Fe*	3	3	350	3.40	4934.08	.08	Ba^+	7	25	1200	0.00
4883.75	.69	Y^+	2	15	600	1.08	4935.78	.84	*Ni*	2	2	300	3.92
4884.66	.60	Cr^+	0	1	300	3.84	4936.25	.34	*Cr*	1	1	300	3.00
4885.07	.09	*Ti*	2	2	300	1.88	4937.40	.35	*Ni*	3	2	300	3.59
4885.43	.44	*Fe*	3	2	300	3.87	4938.12	.18	*Fe*	2	1	300	3.93
4886.37	.34	*Fe*	3	1	350	4.14	4938.84	.82	*Fe*	4	2	350	2.86
4887.11	.10	*Fe-Cr-**	4^2	3d	350	4.17	4939.24	.24	*Fe*	2	1	300	4.14
4888.61	.64	*Fe*	2	1	350	4.09	4939.65	.70	*Fe*	3	2	350	0.86
4889.10	.05	*Fe*	5^2	4	400	2.19	4942.49	.49	*Cr*	2	0	350	0.94
4890.78	.76	*Fe*	6	8	600	2.86	4945.54	.55	*Fe-Ni*	2^2	2d	350	3.78^2
4891.54	.50	*Fe*	8	10	600	2.84	4946.00	.04	*Ni*	0	0	300	3.78
4892.92	.87	*Fe*	1	1	300	......	4946.41	.40	*Fe*	3	3	350	3.35
4893.85	.82	Ce^+-Dy^+-	0^3	1d	300	......	4950.09	.11	*Fe*	2	2	350	3.40
4894.61	.57	....	−1	0	300	......	4952.34	.29	*Fe*	1	0	350	......
4896.50	.45	*Fe*	1	0	300	3.87	4952.64	.65	*Fe*	2	2	350	4.09
4899.89	.91	*Ti*-La^+	2	2	600	1.87	4953.20	.21	*Ni*	2	2	300	3.72
4900.14	.12	Y^+	2	18	600	1.03	4954.60	.60	*Fe*	1	1	350	......
4901.00	.98	*Ni-Ti*	0	0	300	3.46	4954.86	.81	*Cr*	2	2	350	......
4902.28	.30	....	-1^2	1d	300	......	4957.30	.31	*Fe*	5	4	600	2.84
4903.29	.32	*Fe*	5	5	400	2.87	4957.58	.61	*Fe*	8	8	600	2.80
4904.38	.42	*Ni-V*	3	3	400	3.53	4959.07	(.10)	Nd^+	....	2	400	......
4905.15	.14	*Fe*	0	0	300	......	4961.91	.92	*Fe*	0	0	300	......
4907.72	.74	*Fe*	2	1d	300	3.42	4962.57	.58	*Fe*	2	1	300	......
4908.02	.03	*Fe*	0	0	300	......	4964.88	.94	*Cr*	1	0	300	0.94
4909.29	.39	*Fe*	2	1d	300	3.91	4965.22	.18	*Ni*	0	0	300	3.78
4910.00	.02	*Fe*	3	1	350	3.38	4966.15	.10	*Fe*	4	3	350	3.32
4910.32	.33	*Fe*	2	1	350	4.17	4967.85	.90	*Fe*	3	3	350	......
4910.61	.57	*Fe*	2	1	350	4.20	4968.62	.67	*Fe-Ti*	2^2	1	350	1.97^2
4911.17	.20	Ti^+	1	2	350	3.11	4969.87	.92	*Fe*	3	2	350	......
4911.97	.90	*Ni-Fe*	2^2	1d	350	3.75	4970.45	.50	*Fe*-La^+	1	2	350	0.32^2
4913.58	.62	*Ti*	2	2	350	1.86	4971.35	.35	*Ni-*	1	2	300	4.52
4913.99	.98	*Ni*	2	2	350	3.73	4973.03	.11	*Fe-Ti*	4	3	350	3.94
4917.24	.24	*Fe*	2	2	350	......	4975.42	.39	*Ti-Fe*	0^2	1d	350	2.50
4918.00	.02	*Fe*	1	0	300	......	4976.19	.27	*Ni*	2^2	1	350	1.67
4918.37	.37	*Ni*	2	2	350	3.82	4977.65	.65	*Fe*	0	1	300	......

* *Ni.*

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
4978.20	.20	*Ti*	−1	0	300	1.96	5028.19	.14	*Fe*	2	2	300	......
4978.58	.61	*Fe*	3	2	400	3.97	5029.61	.62	*Fe*	1	1	300	......
4979.62	.59	*Fe*	−1	0	300	......	5031.00	.03	Sc^+	3	8	600	1.35
4980.17	.18	*Ni*	4	3	350	3.59	5031.92	.91	....	−1	0	300	......
4981.72	.74	*Ti*	4	3	350	0.84	5032.80	.74	*Ni*	−1	0	300	3.88
4982.51	.51	*Fe*	4	3	350	......	5035.40	.37	*Ni*	5	2	400	3.62
4983.33	.26	*Fe*	3	3	350	4.14	5035.91	.94	*Ti-Ni*	5^2	2	400	1.45
4983.97	.97	*Fe-Ni*	5^2	4	350	4.09	5036.25	.28	*Fe*	0	1	400	......
4985.29	.26	*Fe*	3	2	350	3.91	5036.49	.47	*Ti*	2	2	400	1.44
4985.59	.56	*Fe*	3	2	350	2.85	5036.87	.92	*Fe*	−1	0	300	......
4986.28	.23	*Fe*	1	0	300	......	5037.75	.75	Ce^+-C_2	-1^2	0	300	......
4986.80	(.82)	La^+	....	1d	300	0.17	5038.41	.40	*Ti*	2	2	400	1.42
4988.99	.96	*Fe*	2	2	350	4.14	5038.63	.60	*Ni*	2	2	400	3.82
4991.11	.16	*Ti-Fe-*	5^2	6d	500	0.83	5039.22	.26	*Fe-Ni*	3	1	350	3.35
4993.47	.52	*Fe-*	1^2	3d	400	......	5039.98	.97	*Ti*	3	1	400	0.02
4994.08	.14	*Fe*	3	2	400	0.91	5040.97	.00	*Fe*	7^2	4	500	0.95
4996.82	.85	*Ni*	1	1	350	3.62	5041.71	.72	*Fe-Ca*	6^2	5d	500	1.48
4997.11	.10	*Ti*	0	1	350	0.00	5042.18	.19	*Ni*	1	1	400	3.64
4998.22	.23	*Ni*	1	0	350	3.59	5043.59	.59	*Ti*	−1	0	300	0.83
4999.49	.51	*Ti*-La^+	3	3d	400	0.82	5044.25	.22	*Fe-Co*	3	1	300	2.84
5000.32	.35	*Ni*	2	1	350	3.62	5045.38	.34	*Ti-*	0^2	0d	300	0.84
5001.04	.99	*Ti*	0	1	350	1.99	5048.04	.07	*Ni*	0	0	350	3.82
5001.85	.87	*Fe*	5	3	400	3.86	5048.47	.44	*Fe*	3	2	400	3.94
5002.82	.80	*Fe*	2	1d	300	3.38	5048.88	.86	*Ni*	2	2	400	3.83
5003.[illegible]2	.75	*Ni*	0	1	350	1.67	5049.85	.83	*Fe*	6	3	600	2.27
5004.05	.05	*Fe*	0	1	350	......	5051.66	.64	*Fe*	4	2	600	0.91
5005.21	.17	....	0	0	350	......	5052.91	.88	*Ti-*	0	2	400	2.16
5005.68	.72	*Fe*	4	3	400	3.87	5054.70	.65	*Fe*	1	0	300	......
5006.13	.12	*Fe*	5	4	400	2.82	5056.06	.99	Si^+-*Fe*	−1	2	350	10.03
5007.24	.25	*Ti-Fe*	5^2	4d	400	0.82	5056.82	.85	*Fe*	1	1	300	......
5009.72	.65	*Ti*	−1	0	350	0.02	5057.53	.49	*Fe*	0	0	300	......
5010.25	.22	Ti^+	−1	2	400	3.08	5057.95	.99	*Fe*	1	0	300	......
5010.94	.94	*Ni*	0	0	400	3.62	5060.07	.08	*Fe*	3	2	400	0.00
5012.08	.09	*Fe*	5^2	3d	400	0.86	5062.12	.11	*Ti*	0	0	300	2.15
5012.49	.45	*Ni*	1	0	350	3.68	5063.17	.22	C_2	0^2	1	300	......
5013.14	.15	*Ti-Cr*	3^2	1	350	2.01	5064.57	.58	*Ti*	4^2	2	450	0.05
5013.67	.70	Ti^+	0	2	400	1.58	5065.00	.02	*Fe*	4^2	3	500	4.24
5014.25	.25	*Ti-Fe*	5^2	2	350	0.81	5065.18	.20	*Fe*	2	2	500	......
5014.98	.95	*Fe*	3	2	350	3.93	5067.21	.16	*Fe-*	3	2	400	4.20
5015.68	(.68)	*He*	....	2	2500	20.52	5067.71	.70	*Cr*	0	0	300	......
5016.15	.17	*Ti*	2	0	350	0.84	5068.74	.77	*Fe*	5	2	500	2.93
5017.53	.59	*Ni*	3	2	350	3.52	5070.01	.04	C_2	0^2	2d	400	......
5018.44	.46	Fe^+	4	25	2000	2.88	5071.49	.49	*Ti*	0	0	300	1.45
5019.76	.74	*Fe*	−1	0	300	3.97	5072.04	.08	*Fe*	3	2	400	......
5020.02	.03	*Ti*	2	1	350	0.83	5072.34	.30	Ti^+	0	2	400	3.11
5021.67	.63	*Fe-*	0^2	0	300	......	5072.64	.68	*Fe*	2	1	300	4.20
5022.26	.24	*Fe*	3	2	400	3.97	5073.43	.46	C_2	−1	2d	300	......
5022.87	.88	*Ti*	2	1	400	0.82	5074.76	.76	*Fe*	5	3	450	4.20
5023.19	.19	*Fe*	0	0	300	......	5075.40	.31	Ce^+-C_2	−1	2	300	......
5023.54	.50	*Fe*	0	0	300	......	5076.24	.28	*Fe*	3	2	400	......
5024.82	.85	*Ti*	3	2	300	0.82	5076.61	.63	C_2	−1	2	400	......
5025.52	.57	*Ti*	1	1	300	2.03	5079.10	.13	*Fe*	7^2	5d	500	2.19
5027.18	.13	*Fe*	3	2	350	4.14	5079.84	.79	*Fe-Ni*	5^2	3d	400	0.99
5027.76	.76	*Fe*	1	1	300	......	5080.59	.54	*Ni*	4	2	400	3.64

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5081.09	.12	*Ni*	3	2	400	3.83	5121.60	.63	*Fe-Ni*	3^2	3	350	3.92^2
5081.72	.72	*Sc*-C_2	1^3	0	300	1.44	5122.97	.01	La^+	−2	2	400	0.32
5082.33	.35	*Ni*	2	1	300	3.64	5123.18	.22	Y^+	0	2	400	0.99
5083.37	.35	*Fe*	4	2	400	0.95	5123.73	.73	*Fe*	3	3	400	1.01
5084.13	.11	*Ni*	3	2	400	3.66	5125.13	.16	*Fe-Ni*	4^2	3	400	4.20
5084.56	.63	C_2	-1^2	1	300	......	5126.23	.20	*Fe-Co*	2	2	350	3.61^2
5085.54	.50	*Sc-Ti*	1^3	1	300	1.43	5126.78	.78	C_2	-1^2	1	300	......
5086.26	.30	C_2	0^2	1	300	......	5127.35	.37	*Fe*	3	1	300	0.91
5087.04	.06	*Ti-Sc*	0	1	400	1.42	5127.82	.88	*Fe*-C_2	0^3	1	300	0.05
5087.45	.43	Y^+	1	7	500	1.08	5128.48	.48	C_2	0^3	1d	300	......
5088.30	.35	*Ni-*	1^2	0	350	3.83	5129.12	.16	Ti^+	3	7	500	1.88
5089.22	.27	C_2	1^2	2	450	......	5129.42	.47	*Ni-Fe*	3^2	2	400	3.66
5090.79	.78	*Fe*	5	3	450	4.24	5130.30	.38	*Ni*	−1	1	350	3.82
5092.10	.10	*Cr*-C_2	0^2	1	350	1.00	5130.56	.59	Nd^+-C_2	−2	1	350	......
5092.80	.81	Nd^+	−2	1	350	......	5131.49	.48	*Fe*	2	2	350	2.21
5093.42	.40	C_2	-2^2	0	300	......	5131.75	.78	*Ni*	1	1	350	3.68
5094.40	.42	*Ni*	0	0	300	3.82	5132.40	.43	Nd^+-C_2	-1^2	1	350	......
5095.21	.26	C_2	1^2	2	350	......	5132.72	.76	*Ti-*	0^2	1	350	2.24
5095.91	.86	C_2	0^3	1	300	......	5133.65	.70	*Fe*	4	4	400	4.16
5097.01	.00	*Fe*	3	2	400	4.26	5134.47	.52	C_2	0^3	1d	350	......
5097.50	.49	C_2	0	1	350	......	5135.65	.65	C_2	-1^2	0	300	......
5098.42	.47	*Fe-*	1^2	1	350	3.91	5136.16	.16	*Fe*-C_2	0^2	0	300	......
5098.72	.71	*Fe*	3	2	400	2.17	5137.06	.08	*Ni*	3	2	350	1.67
5099.22	.25	*Ni-Fe*	2^2	1	400	3.64	5137.42	.40	*Fe*	3	2	350	4.16
5099.96	.94	*Ni*	2	2	400	3.66	5137.66	.64	C_2	-1^2	0	300	......
5100.82	.78	C_2	0^3	2	350	......	5138.38	.33	C_2	-1^3	0	300	......
5101.26	.28	*Sc*-C_2	-1^2	1	350	1.44	5139.25	.26	*Fe*	4	4	500	2.98
5103.00	.98	*Ni*	1	1	300	1.67	5139.43	.48	*Fe*	4	4	500	2.93
5103.55	.56	C_2	0^3	1	300	......	5139.65	.65	*Cr*	−1	1	300	......
5104.13	.12	*Fe*	1^2	1	300	4.16	5141.23	.27	C_2	-1^2	0	350	......
5105.25	.22	C_2	1^3	1	300	......	5141.75	.75	*Fe*	3	1	350	2.41
5105.53	.55	*Fe-Cu*	4	3	400	1.38^2	5142.50	.53	*Fe*	4	3	500	4.24
5106.44	.43	C_2	-1^2	1d	350	......	5142.88	.88	*Fe-Ni*	5^2	3	500	0.95
5107.58	.56	*Fe*	8^2	7d	500	0.99	5144.58	.65	*Cr*-C_2	0^2	0	350	......
5109.20	.18	C_2	-1^2	1	400	......	5145.15	.10	*Fe*	1	1	350	......
5109.70	.66	*Fe*	2	1	400	4.28	5145.52	.47	*Ti*	0	1	350	1.45
5110.46	.41	*Fe*	5	3	600	0.00	5146.12	.12	C_2-	−1	1	350	......
5110.74	.77	*Cr*	−1	1	350	......	5146.50	.49	*Ni*	3	3	500	3.69
5111.33	.33	C_2	-1^2	1	350	......	5147.10	.11	C_2-	−2	1	350	......
5111.66	.67	C_2	-1^2	1	350	......	5147.61	.62	*Ti*-C_2	1^3	2	400	0.00
5112.24	.29	Zr^+	−2	2	350	1.66	5148.13	.16	*Fe*	5^2	3	500	4.24
5113.09	.13	*Cr*	−1	1	350	......	5149.13	.16	C_2	-1^2	1	400	......
5113.47	.45	*Ti*	0	1	350	1.44	5150.18	.20	....	−1	0	350	......
5114.29	.26	C_2	−2	1	350	......	5150.62	.66	C_2	-1^2	1	400	......
5114.55	.52	La^+	−2	1	350	0.23	5150.83	.85	*Fe*	4	3	400	0.99
5115.41	.40	*Ni*	2	2	400	3.82	5151.88	.92	*Fe*	3	2	400	1.01
5116.17	.19	Cr^+	−3	1	350	3.70	5152.21	.19	*Ti*	0	2	400	0.02
5116.68	.73	C_2	-1^2	1	350	......	5153.13	.18	*Fe*-C_2	2^3	3	400	......
5116.93	.90	C_2-Ce^+	−1	1	350	......	5154.10	.08	Ti^+	2	5	500	1.56
5117.97	.94	*Mn*	−1	1	350	3.12	5154.40	.38	C_2	-1^2	1	400	......
5118.17	.13	C_2	-2^2	1	350	......	5155.16	.13	*Ni*	1	0	350	3.88
5119.18	.12	Y^+	−1	2	350	0.99	5155.80	.77	*Ni*	2	2	400	3.88
5119.48	.42	C_2	-1^3	1	350	......	5156.60	.65	C_2-La^+	−1	1	350	0.12^2
5120.43	.47	*Ti*-C_2	1^3	3d	350	2.57	5157.59	.53	C_2	0^3	1	400	......

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5157.95	98	Ni-Zr	−1	1	350	3.59	5212.73	.69	Co	−2	1d	250	3.50
5158.53	.58	C_2	-1^2	0	400	......	5215.19	.19	Fe	3	2	300	3.25
5159.10	.06	Fe	2	2	500	......	5216.31	.28	Fe	3	5	350	1.60
5159.55	.51	C_2	-1^2	1	400	......	5217.40	.40	Fe	3	2	350	3.20
5160.27	.25	C_2-	−1	1	350	......	5218.15	.11	Cu-Fe	2^2	2d	300	3.80
5161.05	.11	C_2	-1^2	1	350	......	5220.12	.20	Ni-Pr$^+$	0	1d	250	3.72
5161.67	.72	C_2	-1^2	1	350	......	5221.80	.77	Cr	0	0	250	......
5162.31	.28	Fe	5	3	400	4.16	5223.17	.19	Fe	0	0	250	......
5162.90	.97	C_2	-1^2	1	350	......	5224.19	.22	Ti-Cr	1^2	0	250	2.12
5163.41	.39	C_2	-1^3	1	350	......	5224.82	.87	Cr-Ti	1^3	1d	300	3.42
5164.24	.23	C_2	-1^3	1	350	......	5225.47	.54	Fe	2	2	300	0.11
5164.71	.73	C_2	-1^2		400	......	5226.53	.55	Ti$^+$	2	10	500	1.56
5164.98	.96	C_2	-1^3	6	500	......	5227.04	.05	Fe-Cr	8^2	8	500	1.55
5165.18*	.19	C_2	-2^2		500	......	5228.39	.38	Fe	1	1	300	......
5166.26	.29	Fe-Cr	3	2	400	0.00	5229.87	.86	Fe	4	4	400	3.27
5167.35	.33	Mg	15	18	1500	2.70	5230.20	.22	Co-Cr	−1	0	300	1.73
	.51	Fe	5			1.48	5232.98	.95	Fe	7	6	400	2.93
5168.99	.99	Fe$^+$-Fe	7^2	25	1500	2.88	5234.63	.63	Fe$^+$	2	15	500	3.21
5170.70	.77	Fe	0	0	300	......	5235.43	.44	Fe-Ni	2^2	2	250	2.58
5171.56	.61	Fe	6	4	600	1.48	5236.22	.21	Fe	0	0	250	......
5172.65	.70	Mg	20	30	2000	2.70	5237.31	.33	Cr$^+$	1	5	350	4.06
5173.73	.75	Ti	2	2	500	0.00	5238.54	.57	Ti-Sr	−2	0	250	0.84
5175.39	.33	....	-1^2	0	300	......	5238.93	.97	Cr	−1	0	250	2.70
5176.57	.57	Ni	1	1	400	3.88	5239.79	.82	Sc$^+$	1	7	400	1.45
5177.36	.30	Fe-Cr	1^2	0	300	3.41^2	5242.50	.50	Fe	2	2	300	......
5180.11	.07	Fe	1	1	300	......	5243.81	.78	Fe	1	2	300	4.24
5183.58	.62	Mg	30	40	2500	2.70	5246.72	.68	Cr$^+$-Ti	-1^2	1	300	3.70
5184.30	.28	Fe	2	1	300	4.26	5247.09	.06	Fe	1	1	300	0.09
5185.85	.91	Ti$^+$	2	5	500	1.88	5247.56	.58	Cr	2	1	300	0.96
5187.96	.92	Fe	1	0	300	......	5249.52	.59	Cr$^+$-Nd$^+$	3	3d	350	3.74
5188.69	.70	Ti$^+$	2	12	700	1.58	5250.17	.22	Fe	2	1	350	0.12
5191.49	.47	Fe-Nd$^+$	4	6	500	3.02	5250.66	.66	Fe	3	3	350	2.19
5191.93	.99	Cr	−1	1	350	3.38	5251.98	.98	Fe	0	2	250	......
5192.43	.36	Fe	5	4	500	2.98	5253.53	.47	Fe	2	2	250	3.27
5192.97	.98	Ti	2	2	300	0.02	5254.90	.96	Fe-Cr	3	4	350	0.11
5194.98	.95	Fe	4	4	400	1.55	5255.28	.23	Cr-Fe-†	1^2	2	350	3.45
5195.48	.48	Fe	2	2	350	4.20	5256.86	.93	Fe$^+$	−1	1	300	2.88
5196.09	.07	Fe	1	0	300	......	5257.79	.73	Co-	0^2	1	250	3.95
5196.48	.45	Cr-Y$^+$	0	1	350	2.70	5259.32	......	....	....	2	300	......
5197.57	.58	Fe$^+$	2	12	500	3.22	5261.70	.71	Ca	3	1	300	2.51
5197.94	.94	....	0	0	300	......	5262.21	.23	Ti$^+$-Ca	4^2	4	300	1.58
5198.73	.72	Fe	3	3	400	2.21	5263.39	.32	Fe	4	2	350	3.25
5200.15	.19	Cr	−1	1	300	3.37	5263.87	.87	Fe	0	1	300	......
5200.42	.42	Y$^+$	0	5	400	0.99	5264.20	.20	Cr-Ca	7^2	3	350	0.96
5201.15	.10	Ti	−2	0	300	2.08	5264.77	.81	Fe$^+$	0	2	350	3.22
5202.27	.32	Fe	6^2	5d	400	2.17	5265.70	.68	Ca-Cr-‡	6^3	2d	350	2.51
5204.54	.55	Cr-Fe	8^2	7d	500	0.94	5266.60	.56	Fe	6	5	400	2.98
5205.75	.73	Y$^+$	0	6	500	1.03	5268.32	.35	Ni	0	0	300	......
5206.05	.05	Cr	5	8	600	0.94	5268.62	.62	Ti$^+$-Fe	−1	3	350	2.59
5208.37	.43	Cr	5	12	600	0.94	5269.55	.55	Fe	8	15	600	0.86
5208.65	.60	Fe	2	1	300	3.23	5270.32	.34	Fe-Ca	7^2	7	500	1.60
5210.32	.39	Ti	3	2d	300	0.05	5272.00	.00	Cr-Eu$^+$	−1	0	350	3.43
5211.37	.42	Ti$^+$-Fe	0^2	0	300	2.58	5273.14	.17	Fe	3	3	350	3.28

* Head of third band. † *Mn*. ‡ *Ti*.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5273.44	.39	$Fe\text{-}Nd^+$	2	3	350	2.47	5337.76	.74	$Fe^+\text{-}Cr^+$	1^2	3	300	3.22
5274.22	.24	Ce^+	−1	2	300	......	5339.98	.94	*Fe*	6	6	300	3.25
5275.01	.98	$Cr^+\text{-}Fe$	0	2	300	4.05	5340.46	.46	*Cr*	0	0	250	3.42
5275.25	.25	*Cr-*	2^2	1	300	2.88	5341.10	.05	*Fe-Mn*	8^2	8d	450	1.60
5275.99	.98	$Fe^+\text{-}Cr$	6^3	20	500	3.19	5342.69	.71	*Co*	1	2	300	4.00
5279.88	.88	Cr^+	0	1	300	4.06	5343.46	.42	*Fe-Co*	3^2	3	300	4.35
5280.33	.29	$Cr^+\text{-}Fe$	1^2	2	300	4.06	5345.78	.81	*Cr*	5	4	350	1.00
5280.60	.63	*Co*	−1	0	300	3.61	5346.59	.55	Fe^+	0	1	350	3.22
5281.80	.80	*Fe*	5	2	350	3.02	5347.48	.53	*Co*	−1	0	250	4.13
5282.31	.40	*Ti*	−1	1	300	1.05	5348.34	.33	*Cr*	4	2	350	1.00
5283.64	.63	*Fe*	6	4	350	3.23	5349.47	.47	*Ca*	4	3	400	2.70
5284.12	.11	Fe^+	1	8	400	2.88	5349.71	.75	*Fe-Sc*	1	1	350	4.37
5285.13	.13	*Fe*	0	0	250	4.42	5350.17	.12	Zr^+	1^3	2	300	1.79
5288.60	.53	*Fe*	2	1	300	......	5351.01	.08	*Ti*	−1	0	300	2.77
5289.58	.66	$Y^+\text{-}Mn$	-1^2	0	300	1.03	5352.01	.05	*Co*	1	3	250	3.56
5292.50	.59	*Fe*	0	0	250	......	5353.43	.42	$Fe\text{-}Ce^+\text{-}*$	4^2	8d	500	4.09
5293.15	.17	Nd^+	−1	4	300	......	5355.74	.74	*Sc*	−1	0	250	1.94
5295.30	.32	*Fe*	0	0	250	......	5357.22	.20	Sc^+	−1	0	250	1.50
5296.69	.70	*Cr*	3	2	300	0.98	5359.21	.20	*Co*	−1	0	250	4.13
5297.40	.39	*Cr*	2	0	300	2.89	5361.66	.63	$Fe\text{-}Nd^+$	1	4	400	......
5298.00	.02	*Cr*	1	0	300	2.89	5362.86	.87	Fe^+	3	15	500	3.19
5298.28	.29	*Cr*	4	3	350	0.98	5364.86	.88	*Fe*	5	4	300	......
5298.82	.79	*Fe*	0	0	250	......	5365.35	.41	*Fe*	3	4	300	......
5300.82	.76	*Cr*	2	1	250	0.98	5367.46	.48	*Fe*	6	6	350	......
5302.05	.05	La^+	−2	1	300	0.40	5368.22	.21	$Cr^+\text{-}Sa^+$	-1^2	0d	250	3.85
5302.35	.31	*Fe*	5	4	350	3.27	5369.63	.60	*Co*	1	2	300	1.73
5303.39	.35	$La^+\text{-}V^+$	1^2	2	300	0.32	5369.98	.98	*Fe*	6	5	350	......
5305.86	.87	Cr^+	0	1	250	3.81	5371.51	.48	*Fe-Ni*	7^2	12d	500	0.95
5307.40	.37	*Fe*	3	3	400	1.60	5373.64	.72	*Fe-Cr*	2	2d	300	4.45
5308.49	.43	Cr^+	0	1	250	4.05	5377.62	.61	*Mn*	2	3	300	3.83
5312.85	.86	*Cr*	0	0	250	3.43	5379.52	.58	*Fe*	3	2	300	......
5313.57	.58	Cr^+	1	2	300	4.06	5380.35	.32	....	0	0	250	......
5315.07	.08	*Fe*	1	1	250	4.35	5381.04	.03	$Ti^+\text{-}La^+$	2	7	400	1.56
5316.67	.71	Fe^+	6^2	30	850	3.14	5382.20	.28	....	0	0d	250	......
5318.32	.36	$Sc^+\text{-}Cr^+$	−1	0	250	1.35	5383.32	.38	*Fe*	6	6	400	......
5318.78	.78	*Cr*	0	0	250	3.42	5385.57	.59	....	−1	0	250	......
5319.87	.90	$Nd^+\text{-}Fe$	1^2	3d	300	......	5386.37	.34	*Fe*	1	0	250	......
5321.09	.12	*Fe*	2	1	300	......	5387.50	.53	*Fe-Cr*	0^2	0	250	......
5322.08	.05	*Fe*	3	1	300	2.27	5388.36	.36	*V-Ni*	0^2	0d	250	2.55
5324.22	.19	*Fe*	7	7	400	3.20	5389.48	.49	*Fe*	3	2	350	4.40
5325.59	.56	Fe^+	2	6	400	3.21	5390.31	.36	*Cr-Ti*	1^3	1d	300	1.86^2
5326.13	.16	*Fe*	1	0	250	......	5391.42	.47	*Fe*	2	2	350	4.14
5326.77	.82	*Fe*	−1	0	250	4.40	5391.65	.62	*Fe*	1	1	350	......
5328.03	.05	*Fe*	8	10	500	0.91	5392.10	.18	*Ni-Sc*	0^2	0	250	4.14
5328.44	.47	*Fe-Cr*	6^2	8	500	1.55	5393.20	.18	*Fe*	5	4	400	3.23
5329.18	.15	*Cr*	3	2	350	2.90	5393.42	.39	Ce^+	−2	2	350	......
5329.96	.00	*Fe*	2	2	350	......	5394.67	.68	*Mn*	2^2	3	350	0.00
5330.61	.57	Ce^+	−2	1	250	......	5395.18	.22	*Fe*	0	1	250	......
5331.40	.46	*Co*	−1	0	250	1.78	5396.27	.25	Ti^+	−1	1	250	......
5332.68	.67	*Fe-Co*	1	1	350	3.55^2	5397.14	.14	*Fe*	7	7	600	0.91
5332.90	.91	*Fe*	4	5d	350	1.55	5397.66	.62	*Fe*	1	1	300	......
5334.88	.87	Cr^+	1	1	300	4.06	5398.27	.29	*Fe*	3	3	350	4.43
5336.77	.80	Ti^+	4	8	450	1.58	5399.43	.48	*Mn*	1	2	350	3.84

* *Ni.*

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5400.46	.51	*Fe*	3	5	400	4.35
5401.27	.27	....	0	0	250	......
5401.99	.91	*V-*	0^3	1d	300	......
5402.76	.78	Y^+	0	2	350	1.84
5403.88	.83	*Fe*	2	3	350	......
5404.12	.15	*Fe*	5	6	450	4.29
5405.39	.36	....	1	1	300	......
5405.84	.79	*Fe*	6	10	600	0.99
5406.80	.78	....	1	0	300	......
5407.50	.50	Cr^+-*Mn*	1^2	3d	450	2.13
5409.16	.14	*Fe*	2	2	300	4.35
5409.81	.80	*Cr*	4	5	350	1.03
5410.89	.92	*Fe*	4	5	400	4.40
5411.24	.22	*Ni*	1	1	300	4.07
5414.04	.08	Fe^+	−1	3	300	3.21
5415.23	.21	*Fe*	5	5	400	4.35
5417.05	.04	*Fe*	0	1	250	4.40
5418.80	.78	Ti^+	1	6	400	1.58
5420.30	.36	*Mn*	1^2	2	400	2.13
5420.94	.93	Cr^+	−1	1	250	3.74
5421.20	.18	....	0	0	250	......
5422.02	.00	*Fe-*	0^2	0	250	4.30
5424.07	.08	*Fe*	6	6	350	......
5424.65	.66	*Ni*	1	1	300	1.94
5425.30	.26	Fe^+	1	8	350	3.19
5429.50	.51	*Fe*	1	1	350	4.17
5429.73	.71	*Fe*	6	15*	600	0.95
5430.36	.37	Cr^+	−1	0	250	3.84
5431.60	.55	Nd^+	−2	2	300	......
5432.40	.49	*Mn-Cr*	2^2	2	350	0.00
5432.90	.96	*Fe*	2	3	400	4.43
5433.60	.53	*Mn-*	0^2	0	250	......
5434.54	.54	*Fe*	5	10	500	1.01
5435.80	.87	*Ni*	2	1	350	1.98
5436.32	.30	*Fe*	1	1	350	......
5436.63	.60	*Fe*	1	1	350	2.27
5437.20	.21	*Fe*	−1	0	250	4.29
5441.32	.35	*Fe*	1	0	250	......
5444.56	.59	*Co*	−1	2	250	4.05
5445.03	.06	*Fe*	4	5	350	4.36
5446.86	.86	*Fe-Ti*	8^2	12d	500	0.99
5448.40	.38	*Fe*	−1	0	300	......
5451.07	.13	Nd^+	−2	1	300	......
5452.06	.11	Ti^+-	−1	1	300	......
5453.18	.24	*Ni*	−1	0	250	4.07
5453.98	.00	....	−1	0	250	......
5454.60	.58	*Co*	−1	0	300	4.05
5455.59	.57	*Fe*	6^2	12	500	1.01
5460.49	.51	*Ti*	−1	0	300	0.05
5362.55	.50	*Ni*	1	1	300	3.83
5362.95	.97	*Fe*	3	2	350	4.45
5463.26	.29	*Fe*	3	4	400	4.42
5464.15	.19	*Fe-Cr*	1^2	1d	300	......
5466.41	.41	*Fe-Y*	3	3	300	4.35
5466.97	.00	*Fe*	1	0	250	3.64
5468.47	.39	Ce^+-*Ni-*	0^3	0d	250	3.83^2
5470.10	.10	....	−1	0	300	......
5470.64	.64	*Mn*	1^2	3	300	2.15
5472.36	.30	Ce^+	−2	0	350	......
5472.72	.72	*Ti-Fe*	1	3	350	1.44
5473.37	.39	Y^+	−2	0	300	1.73
5473.89	.91	*Fe*	3	3	450	4.14
5474.40	.35	*Ti-*	0^2	0d	300	1.45
5476.27	.30	*Fe*	1	1	400	......
5476.76	.58	*Fe*	3	4	400	4.09
	.92	*Ni*	5	7	500	1.82
5477.71	.71	*Ti*	−1	1	250	2.42
5478.42	.38	Cr^+	−1	2	250	4.16
	.47	*Fe*	0	0	250	4.17
5480.60	.57	Y^+-*Cr*	0^2	2	250	1.71
5480.92	.87	*Fe-Ni*	1	2	250	4.20
5481.38	.35	*Fe-Ti*	2^2	2	300	4.17
5481.85	.90	*Ti-Sc*	0^2	1	250	1.42
5483.10	.11	*Fe*	1	0	300	4.14
5483.38	.37	*Co-Ni*	1	3	350	1.70
5483.88	.91	*Co*	−2	0	250	3.62
5484.64	.65	*Sc*	−2	1	250	1.84
5485.63	.71	Nd^+	−3	2	300	......
5487.14	.16	*Fe*	1	1	300	......
5487.54	.52	....	−1	0	300	......
5487.78	.76	*Fe*	3	5	350	......
5489.75	.77	....	0^2	1	·300	......
5490.11	.16	*Ti*	0	0	250	1.45
5490.72†	.70	....	0	3	350	......
5491.90	.85	*Fe*	−1	0	250	......
5493.51	.51	*Fe*	1	1	300	4.09
5494.45	.48	*Fe*	0	0	250	......
5497.42	.42	Y^+	−3	0	500	1.74
	.53	*Fe*	5	8	500	1.01
5499.55	.60	....	−1	0	250	......
5501.47	.48	*Fe*	5	7	400	0.95
5502.04	.09	Cr^+	−1	0	250	4.15
5503.02	.08	*Fe*-Cr^+	1	2	300	4.13^2
5503.44	.38	*Y-Co*	0^2	0	300	......
5503.98	.98	*Ti-Ni*	1^2	1	300	2.57
5505.84	.89	*Mn*	1	3	300	2.17
5506.81	.79	*Fe*	5	6	400	0.99
5508.56	.53	Cr^+-Nd^+	1^2	3d	350	4.14
5509.96	.99	Y^+-*Ni*	2^2	7d	400	0.99
5510.62	.68	Cr^+-	1^2	2	350	3.81
5512.27	.27	*Fe*	1	1	300	......
5512.52	.54	*Ti*	2	4	350	1.45
5513.00	.99	*Ca*	4	2	350	2.92
5514.29	.36	*Ti*	2	4	350	1.42
5514.57	.55	*Ti*	2	4	350	1.44
5516.74	.78	*Mn*	1^2	2	350	2.17

* Relatively stronger than other lines of multiplet. † Enhanced in *α* Persei.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5517.05	.08	Fe	0	0	250	......	5587.59	.58	Fe	0	1	300	......
5517.56	.55	....	−1	0	250	......	5587.86	.87	Ni	1	4	400	1.93
5519.60	.59	Fe	0	0d	250	......	5588.74	.77	Ca	6	6	600	2.52
5520.70	.74	Sc-	0^2	0	250	1.86	5589.38	.37	Ni	0	1	300	3.88
5521.18	.22	Fe-	0^2	0	300	4.40	5590.10	.13	Ca	3	1	400	2.51
5521.64	.59	Y^+-Y	−1	3	500	1.73	5590.85	.84	Co	-1^3	1	400	2.03
5522.45	.46	Fe	2	2	350	4.19	5592.28	.27	Ni	1	5	400	1.94
5525.61	.56	Fe	2	2	350	4.19	5593.66	.75	Ni	0	1d	400	3.88
5526.90	.82	Sc^+	3	15	600	1.76	5594.57	.51	Ca-Fe	5^2	7	500	2.51
5527.60	.59	Y-Ti	−2	0	250	1.39	5596.19	.19	C_2	−2	0d	300	......
5528.41	.42	Mg	8	8	400	4.33	5598.43	.46	Ca-Fe	5^2	8d	500	2.51
5529.09	.04	Fe	1^2	0d	300	4.45	5599.99	.03	....	−1	0	400	......
5530.80	.79	Co	−1	2	400	1.70	5600.24	.24	Fe	0	3d	400	4.24
5532.00	.99	....	−1	1	300	......	5601.31	.29	Ca-Ce^+	3	3d	600	2.52
5532.85	.80	Fe-	2^2	2	300	......	5602.92	.93	Fe-Ca	7^2	8	600	3.42
5534.86	.85	Fe^+	2	15	600	......	5603.73	.78	C_2	−1	1	350	......
5535.41	.46	Fe-Mn	3^2	2	350	......	5607.65	.67	C_2	−1	0	250	......
5537.75	.76	Mn	0^2	2d	350	2.18	5610.14	.12	Ce^+-C_2	-1^2	1d	350	......
5538.51	.52	Fe	1	0	350	......	5612.43	.43	C_2	-1^2	0	250	......
5539.26	.30	Fe	0	0	300	......	5614.74	.78	Ni-Ce^+	0	1	250	4.14
5540.09	.08	Sr-C_2	-1^2	0	300	2.25	5615.29	.31	Fe	2	2	350	2.58
5540.75	.73*	C_2	−2	0	300	......	5615.65	.66	Fe	6	10	600	3.32
5543.22	.20	Fe	2	3	350	......	5617.23	.20	Fe-	1^2	0	300	......
5544.00	.95	Fe	2	2	350	4.20	5618.66	.64	Fe	1	0	250	4.19
5544.66	.62	Y^+-Y	−2	2	350	1.73	5619.64	.61	Fe	0	0	250	4.37
5546.56	.52	Fe	2	1	300	4.35	5620.53	.50	Nd^+-Fe	0	1	250	4.14^2
5547.01	.00	Fe	1	0	300	4.20	5622.99	.97	Ce^+-C_2	0	1	250	......
5549.83	.81	....	0^2	0	350	......	5624.03	.03	Fe	1	1	350	......
5551.96	.98	Mn	−2	1	300	......	5624.55	.56	Fe	4	3	400	3.40
5553.61	.63	Fe-Ni	2^2	2	350	4.42	5625.40	.45	Ni-	1^2	2d	350	4.07
5554.92	.90	Fe	3	4	400	4.53	5627.61	.65	V	−1	0	250	1.08
5557.92	.96	Fe-	1^2	2	350	4.45	5627.99	.03	C_2	−2	0	250	......
5558.79	.85	Co-V	−2	0d	250	......	5628.49	.51	Cr-Ni	0^2	0d	250	4.07^2
5560.17	.22	Fe	2	2	300	4.42	5631.86	.85	C_2	0^3	0d	250	......
5561.21	.25	Nd^+	−1	0	250	......	5633.96	.96	Fe	3	2	350	......
5562.75	.72	Fe	2	2	350	4.42	5634.86	.86	C_2	-2^2	0	300	......
5563.59	.61	Fe	3	4	500	4.17	5635.22	.20‡	C_2	−2	1d	300	......
5565.48	.49	Ti	−1	0	300	2.23	5635.80	.83	Fe	1	1	300	......
5565.71	.72	Fe	3	7	500	4.59	5637.25	.27	Fe-Ni	2^2	2d	350	4.07^2
5566.11	.09	....	−1	0	250	......	5638.28	.27	Fe	3	3	350	4.20
5567.37	.40	Fe	2	4	400	2.60	5640.26	.32	....	0	0	300	......
5568.88	.88	Fe	−1	0	300	......	5640.93	.99	Sc^+	1	5	400	1.49
5569.69	.63	Fe	6	7	600	3.40	5641.45	.45	Fe	2	2	350	4.24
5572.87	.89	Fe-	7^2	8	600	3.38	5642.82	.87	Ni-Ti	1^3	0d	250	4.15
5574.92	.91	Fe	−2	0	300	......	5644.10	.15	Ti	0	4d	400	2.26
5576.08	.10	Fe	4	6	500	3.41	5645.65	.62	Si	1	0	250	4.91
5577.04	.04	....	−1	0d	300	......	5646.69	.69	....	−1	0	250	......
5578.69	.73	Ni	1	4	500	1.67	5647.23	.24	Co	−1	0	250	2.27
5582.03	.98	Ca	4	2	500	2.51	5648.64	.58	Ti	−1	1	250	2.48
	.52	V-C_2	−2			1.06	5649.44	.40	Cr	−1	1	350	3.82
5585.07	.78	Fe-C_2	0	3d	400	......	5649.86	.89	Fe-Ni	2^2	2	350	......
	.60†	Ti-C_2	−2			......	5650.65	.70	Fe	1	0	250	......
5586.83	.77	Fe	7	8	600	3.35	5651.45	.48	Fe	0	0	250	4.45

* Third head of second band. † Second head of second band. ‡ First head of second band.

TABLE V—*Continued*

Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromo-sphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5652.37	.33	*Fe*	1	1	250	......	5715.12	.10	*Ni-Fe*	5	5	400	4.07
5653.88	.88	*Fe*	1	0	250	......	5717.86	.84	*Fe*	4	5	400	4.27
5655.17	.19	*Fe*	1	1	350	......	5719.58	.58	....	1	0	300	......
5655.52	.50	*Fe*	2	5	500	4.24	5720.45	.45	*Ti*	0	0	350	2.28
5657.84	.88	Sc^+	2	10	600	1.50	5727.06	.06	*V-Ti*	2	4	350	1.08
5658.29	.35	Sc^+	0	5	500	1.49	5730.90	.86	*Fe*	0	0	300	......
5658.67	.74	*Fe*	6^3	5	500	3.38	5731.73	.78	*Fe*	4	2	300	4.24
5659.60	.60	....	0	0	300	......	5732.33	.31	....	0	0	300	......
5660.70	.74	*Fe-*	1^2	1d	300	......	5741.82	.86	*Fe*	2	0	250	4.24
5661.35	.36	*Fe*	0	0	300	......	5747.74	.67	....	1	0	250	......
5662.16	.16	*Ti*	0	0	300	2.31	5747.92	.96	*Fe*	2	1	250	......
5662.50	.53	*Fe*	4	3	400	4.16	5748.40	.36	*Ni*	2	1	250	1.67
5662.93	.94	Y^+-*Ti*-*	1	6	500	1.94	5752.00	.04	*Fe*	4	3	300	4.53
5664.02	.01	*Ni-Cr*	1	1	300	4.52	5753.15	.14	*Fe*	5	5	400	4.24
5665.58	.57	*Si*	1	0	300	4.90	5754.64	.67	*Ni*	5	5	400	1.93
5666.67	.69	....	0	0	300	......	5756.85	.83	*Fe?*	2	1	250	......
5667.20	.16	Sc^+	0	4	500	1.49	5760.34	.36	*Fe*	1	1	300	......
5667.49	.53	*Fe*	2	1	300	2.60	5760.86	.84	*Ni*	2	2	300	4.09
5669.02	.04	Sc^+	1	5	500	1.49	5762.40	.43	*Fe*	1	1	400	......
5669.83	.85	*Ni-*	1^2	1d	250	4.25	5763.03	.99	*Fe*	7^2	6	400	4.19
5670.78	.86	*V*	0	0	350	......	5769.19	.22	La^+-Ce^+	1^3	1d	300	1.25
5671.89	.84	*Sc*	0	1d	300	1.44	5772.18	.15	*Si*	3	1	300	4.90
5675.43	.44	*Ti*	2	3	350	2.30	5775.14	.09	*Fe*	4	2	300	4.20
5679.04	.03	*Fe*	3	4	350	4.63	5778.42	.47	*Fe*	1	1	300	2.58
5682.18	.21	*Ni*	2	2	300	4.09	5780.65	.61	*Fe-Ti*	3^3	2d	300	3.25
5682.65	.65	*Na*	5	2	300	2.09	5782.16	.14	*Fe-Cu*	6^2	5	400	4.26
5684.23	.20	Sc^+	1	5	400	1.50	5783.06	.08	*Cr*	2	1	300	......
5684.49	.50	*Si*	3	1	300	4.90	5783.90	.87	*Cr*	3	2	300	......
5685.46	.44	....	−1	0	250	......	5785.11	.17	*Fe-Cr*	5^2	3	350	4.53
5686.53	.54	*Fe*	3	4	300	......	5785.88	.82	*Cr-Ti*	2^2	1	350	......
5688.23	.22	*Na*	6	3	350	2.10	5787.91	.93	*Cr*	4	3	350	......
5690.50	.44	*Si*	3	1	300	4.91	5791.02	.99	*Cr-Fe*	7^2	5	400	3.20^2
5691.45	.51	*Fe-Ni*	2	1	250	4.28	5793.13	.08	*Si*	3	1	300	4.91
5693.69	.65	*Fe*	3	2	350	......	5793.93	.93	*Fe*	2	1	300	4.20
5694.89	.90	*Ni-Cr*	3^2	3d	350	4.07	5798.00	.05	*Fe-Si*	7^2	4d	400	3.91
5698.33	.34	*Cr-Fe*	1	4	350	3.86	5804.28	.21	*Fe-Ti*	2^3	3	350	3.86
5698.58	.53	*V*	1	1	350	1.06	5805.27	.23	*Ni*	4	3	300	4.15
5700.23	.24	*Sc-Ni*	1^2	0	300	1.43	5806.70	.74	*Fe*	5	3	300	4.59
5701.12	.11	*Si*	1	0	400	......	5809.27	.23	*Fe*	4	3	350	3.87
5701.50	.56	*Fe*	4	3	500	2.55	5811.93	.93	*Fe*	0	1	300	......
5702.38	.33	*Cr*	0	0	300	1.05	5814.85	.82	*Fe*	1	0	300	4.26
5703.57	.59	*V*	1	2	400	1.05	5816.35	.38	*Fe*	5	4	350	......
5704.74	.75	*Fe*	0	0	250	......	5827.86	.89	*Fe*	0	0	300	3.27
5705.41	.48	*Fe*	1	1	300	4.28	5831.64	.61	*Ni*	1	0	300	4.15
5706.00	.01	*Fe*	3	4	350	4.59	5838.30	.31	*Fe*-Ce^+	1^2	1	300	3.93
5706.99	.03	*Fe-V*	2^2	2d	350	1.04^2	5848.16	.13	*Fe*	3	2	300	3.25
5708.25	.10	*Fe*	1	2d	400	4.42	5852.24	.23	*Fe*	3	2	300	4.53
	.41	*Si*	3			4.93	5853.69	.69	Ba^+	5	12	600	0.60
5709.37	.39	*Fe*	5	6	400	3.35	5855.07	.09	*Fe*	1	1	300	......
5709.61	.56	*Ni*	5	3	300	1.67	5856.13	.10	*Fe*	2	2	300	......
5711.02	.10	*Mg*	6	2	400	4.33	5857.51	.54	*Ca-Ni*	11^2	10	400	2.92
5711.89	.89	*Fe-Ni*	3	4	400	4.26	5859.54	.60	*Fe*	5	6	300	4.53
5712.16	.14	*Fe*	2	2	300	3.40	5862.42	.37	*Fe*	6	7	400	4.53

* *Fe.*

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
5864.29	.25	*Fe*	0	0	250	4.28	6081.44	.46	*V*	0	0	300	1.05
5866.46	.46	*Ti*	3	5	300	1.06	6082.75	.72	*Fe*	1	0	300	2.21
5867.58	.57	*Ca*	2	0	300	2.92	6085.23	.26	*Ti-Fe*	2	1	300	1.05
5875.64	(.62)	*He*	....	80	7500	20.87	6089.60	.58	*Fe*	1	0	300	......
5883.80	.82	*Fe*	4	3	300	3.94	6090.20	.22	*V*	2	2	300	1.08
5889.98	.98	$Na(D_2)$	30	25	1500	0.00	6093.70	.66	*Fe*	2	1	300	......
5892.86	.88	*Ni*	4	4	400	1.98	6094.41	.38	*Fe*	1	1	300	......
5895.99	.94	$Na(D_1)$	20	20	1500	0.00	6096.65	.68	*Fe*	3	2	300	3.97
5899.36	.31	*Ti*	1	3	300	1.05	6102.15	.19	*Fe*	6	4	400	4.81
5905.70	.68	*Fe*	4	4	400	......	6102.71	.73	*Ca*	9	8	800	1.87
5909.96	.98	*Fe*	1	1	300	3.20	6103.25	.22	*Fe*	5^2	4	400	4.81
5914.14	.12	*Fe*	4	8	400	4.59	6108.15	.13	*Ni*	6	3	400	1.67
5916.26	.26	*Fe*	3	5	400	2.44	6111.10	.08	*Ni*	2	1	300	4.07
5918.55	.56	*Ti*	0	2	300	1.06	6111.66	.67	*V*	0	0	300	1.04
5922.12	.13	*Ti*	0	2	300	1.04	6116.17	.20	*Ni-Fe*	5^2	2	400	4.07
5927.80	.80	*Fe*	2	1	300	......	6119.60	.61	*V-Ni*	2^2	0	300	1.06
5929.68	.69	*Fe*	2	0	300	......	6122.28	.23	*Ca*	10	10	800	1.88
5930.23	.19	*Fe*	6	7	400	4.63	6125.05	.03	Ce^+-	1	1	300	......
5934.70	.67	*Fe*	5	4	400	3.91	6126.28	.23	*Ti*	1	0	300	1.06
5941.75	.77	*Ti*	−1	0	300	1.05	6127.92	.92	*Fe*	3	2	300	2.27
5948.55	.55	*Si*	6	2	400	5.06	6136.78	.73	*Fe*	11^2	10	800	2.44
5949.37	.35	*Fe*	1	2	300	0.91	6137.68	.71	*Fe*	7	7	600	2.58
5952.68	.73	*Fe*	4	3	400	3.97	6141.77	.73	Ba^+-*Fe*	7	20	1500	0.70
5953.22	.17	*Ti*	1	3	400	1.88	6145.01	.03	....	2	2	400	......
5956.73	.71	*Fe*	4	4	400	0.86	6147.78	.80	Fe^+-*Fe*	5^2	6	600	3.87
5965.84	.84	*Ti*	2	3	400	1.87	6149.24	.26	Fe^+	2	5	600	3.87
5975.31	.36	*Fe*	3	2	300	......	6151.68	.63	*Fe*	4	2	300	2.17
5976.83	.79	*Fe*	4	2	350	3.93	6154.26	.24	*Na*	2	2	300	2.09
5978.58	.55	*Ti*	1	2	350	1.86	6155.22	.15	....	7	3	400	......
5983.70	.69	*Fe*	5	4	400	4.53	6157.76	.74	*Fe*	5	4	400	......
5984.82	.83	*Fe*	6	6	400	4.71	6160.68	.76	*Na*	3	1	300	2.10
5987.08	.08	*Fe*	5	6	400	4.78	6161.28	.30	*Ca*	4	2	300	2.51
5991.36*	.38	....	2	7	400	......	6162.19	.18	*Ca*	15	15	1000	1.89
5997.78	.74	*Fe-Ni*	3^2	3d	300	4.59	6163.76	.71	*Ca-Fe*	4^2	3	400	2.51
6003.05	.03	*Fe*	6	5	400	3.86	6165.30	.37	*Fe*	3	2	400	......
6005.54	.56	*Fe*	1	1	300	2.58	6166.44	.45	*Ca*	5	2	400	2.51
6008.00	.97	*Fe*	4	3	400	4.63	6169.02	.05	*Ca*	6	4	600	2.51
6008.58	.57	*Fe*	6	5	400	3.87	6169.51	.57	*Ca*	7	5	600	2.52
6012.21	.24	*Ni*	1	0	300	......	6170.50	.52	*Fe-Ni*	6	4	600	4.78
6013.55	.50	*Mn*	6	3	400	3.06	6173.32	.35	*Fe*	5	4	400	2.21
6016.68	.65	*Mn*	6	3	400	3.06	6175.36	.38	*Ni*	3	2	400	4.07
6020.10	.13	*Fe*	6^2	6	400	4.59	6176.81	.82	*Ni*	5	3	400	4.07
6021.86	.81	*Mn*	6	3	400	3.06	6180.20	.22	*Fe*	5	2	400	2.72
6024.09	.07	*Fe*	7	5	400	4.53	6186.70	.72	*Ni*	2	0	300	4.09
6027.01	.06	*Fe*	4	3	400	......	6188.04	.00	*Fe*	4	2	400	3.93
6039.75	.74	*V*	0	0	300	1.06	6191.13	.19	*Ni*	6	3	400	1.67
6042.10	.11	*Fe*	3	3	400	4.71	6191.64	.58	*Fe*	9	8	600	2.42
6053.66	.70	*Ni*	0	0	300	4.22	6194.50	.43	....	0	0	300	......
6056.03	.02	*Fe*	5	4	400	4.71	6199.14	.20	*V*	0	0	300	0.28
6062.87	.87	*Fe*	0	0	300	2.17	6200.37	.33	*Fe*	6	4	400	2.60
6065.53	.50	*Fe*	7	7	500	2.60	6213.38	.44	*Fe*	6	5	500	2.21
6078.47	.50	*Fe*	5	4	400	4.78	6215.20	.16	*Fe-Ti*	5	4	400	2.68^2
6079.05	.02	*Fe*	2	2	400	4.63	6216.32	.37	*V*	1	0	300	0.27

* Strongly enhanced in α Persei.

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
6219.34	.29	Fe	6	6	500	2.19	6383.68	.73	Fe^+	0	2	400	......
6224.02	.00	Ni	1	0	300	4.09	6393.68	.62	Fe	7	10	600	2.42
6226.80	.74	Fe	1	0	300	3.87	6400.02	.08	Fe	10^2	12	600	3.59
6229.19	.24	Fe	1	0	300	2.83	6407.28	.31	Fe^+	0	3	400	3.87
6230.76	.74	Fe-V	8	10	600	2.55	6408.00	.03	Fe	5	4	400	3.67
6232.70	.66	Fe	3	3	400	3.64	6411.72	.66	Fe	7	7	500	3.64
6237.40	.33	....	3	2	400	.....	6414.82	.87	Fe-Ni	2^2	1	300	4.14^2
6238.45	.40	Fe^+	2	5	500	3.87	6416.98	.94	Fe^+	1	4	500	3.88
6239.92	.96	Fe^+	−1	2	400	3.87	6419.94	.96	Fe	4	4	500	4.71
6240.70	.66	Fe	3	1	300	2.21	6421.45	.37	Fe	7	7	600	2.27
6243.79	.83	Fe	2	1	300	......	6430.88	.86	Fe	5	7	600	2.17
6244.46	.48	....	2	1	300	......	6432.63	.69	Fe^+	1	9	600	2.88
6245.64	.63	Sc^+	1	4	400	1.50	6436.45	.43	Fe	0	0	300	......
6246.27	.33	Fe	8	7	500	3.59	6439.04	.09	Ca	8	9	600	2.52
6247.56	.57	Fe^+	2	10	600	3.88	6449.83	.83	Ca	6	6	500	2.51
6252.51	.57	Fe	7	7	500	2.39	6455.62	.61	Ca	2	1	300	2.51
6254.28	.24	Fe	6^2	5	400	2.27	6456.44	.40	Fe^+	3	15	600	3.89
6256.43	.37	Fe-Ni	6	4	400	2.44	6462.58	.64	Ca-Fe	8^2	10	600	2.51
6258.11	.12	Ti	2	2	300	1.44	6469.26	.20	Fe	2	3	400	2.39
6258.75	.72	Ti	3	2	300	1.45	6471.63	.68	Ca	5	3	400	2.52
6261.09	.11	Ti	1	0	300	1.42	6475.58	.64	Fe	2	2	400	2.55
6265.22	.15	Fe	5	4	400	2.17	6481.83	.89	Fe	3	3	400	2.27
6270.21	.24	Fe	3	2	400	2.85	6482.76	.82	Ni	1	2	400	1.93
6279.70	.74	Sc^+	0	3	400	1.49	6491.65	.59	Ti^+	1	2	400	2.05
6280.66	.63	Fe	3	3	400	0.86	6493.74	.80	Ca	6	4	400	2.51
6286.15	.16	....	0	0	300	.....	6494.95	.00	Fe	8	10	600	2.39
6291.03	.98	Fe	4	3	400	4.71	6496.40	.48	Fe	2	2	400	......
6297.85	.81	Fe	5	5	500	2.21	6496.88	.92	Ba^+	4	20	1500	0.60
6301.48	.52	Fe	7	7	500	3.64	6499.00	.95	Fe	1	1	300	0.95
6302.46	.51	Fe	5	3	500	3.67	6499.70	.66	Ca	4	1	300	2.51
6311.50	.51	Fe	1	0	300	2.82	6516.16	.09	Fe^+	2	12	800	2.88
6314.73	.68	Ni	4	5	500	1.93	6518.44	.38	Fe	2	2	400	2.82
6315.34	.32	Fe	2	3	400	......	6546.24	.26	Fe-Ti	6	4	400	2.75
6315.85	.82	Fe	1	0	300	......	6562.80	.82	$H\alpha$	40	200	12000	10.16
6318.00	.04	Fe	6	7	600	2.44	6569.30	.23	Fe	5	3	400	4.71
6318.70	.71	....	1	2	300	......	6575.00	.04	Fe	2	2	400	2.58
6320.85	.86	Sc^+	−1	2	400	1.49	6592.93	.93	Fe	6	5	400	2.72
6322.74	.70	Fe	4	5	400	2.58	6593.85	.89	Fe	4	3	400	2.42
6327.67	.61	Ni	2	2	300	1.67	6604.55	.61	Sc^+	1	3	400	1.35
6330.85	.86	Fe	2	1	300	......	6609.20	.13	Fe	3	2	400	2.55
6335.28	.34	Fe	6	7	500	2.19	6633.79	.77	Fe-	3^3	2	300	......
6336.90	.84	Fe	7	8	500	3.67	6643.70	.65	Ni	5	5	400	1.67
6339.02	.00	Fe-Ni	4^2	3d	400	4.14^2	6663.50	.42	Fe	4^2	3	400	2.41
6344.14	.16	Fe	4	3	400	2.42	6678.10	(.15)	He-Fe	5	20	2200	21.13
6347.05	.10	Si^+	2	8	800	8.08	6703.60	.58	Fe	1	0	300	2.75
6355.04	.04	Fe	4	5	500	2.83	6705.10	.12	Fe	1	0	300	......
6358.66	.70	Fe	6	6	500	0.86	6717.75	.70	Ca	5	3	400	2.70
6362.88	.88	Cr-Fe	2	2	300	0.94	6726.68	.68	Fe	2	2	300	......
6364.44	.49	Fe	2^2	2d	300	......	6733.20	.17	Fe	1	0	300	4.62
6366.55	.50	Ni	0	0	300	4.15	6750.14	.17	Fe	3	2	400	2.41
6369.53	.48	Fe^+	0	5	500	2.88	6752.80	.72	Fe	1	0	300	4.62
6371.36	.36	Si^+-Fe	1	7	700	8.08	6810.24	.28	Fe	3	2	400	......
6380.75	.76	Fe	4	2	400	......	6828.60	.61	Fe	2	1	300	4.62

TABLE V—*Continued*

Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.	Chromosphere	Sun	Element	Disk	Flash	Height in Km	E.P.
6841.40	.36	*Fe*	3	2	400	4.59	6945.20	.22	*Fe*	4	2	400	2.41
6843.64	.67	*Fe*	3	2	400	4.53	6978.83	.88	*Fe*	2	1	300	2.47
6855.10	.18	*Fe*	3	2	400	4.59	7023.00	.97	*Fe*	2	1	300	4.17
6914.62	.58	*Ni*	4	2	400	1.94	7065.20	(.18)	*He*	....	6	1000	20.87

IDENTIFICATION OF LINES

Much time and energy have been spent in the attempt to make as complete as possible the identifications of the lines of the flash spectrum. In *Handbuch der Astrophysik*, **4**, 286, the method followed is explained in detail. For the present revision the writer had the opportunity of spending two months in each of the summers of 1926 and 1929 at the Mount Wilson Observatory. Director Adams freely put at my disposal all of the abundant spectroscopic material that has been accumulated for the *Revision of Rowland's Tables*. The method adopted in the present discussion is identical with that followed in the revision of Rowland. For each line of the flash spectrum, Miss Charlotte E. Moore wrote out in the list of flash lines given her the possible coincidences in wave-length, together with the designation of the multiplet group, and King's estimates of the intensities in the arc spectrum and temperature class. When this material had been all assembled, the next step was to come to a decision regarding the sources producing each line in the flash spectrum. For this part of the discussion the writer alone is responsible for the final decision. These methods were followed throughout the whole of the spectrum included in the present revision. Hence for the region at the violet end of the spectrum, taken from the published results of Davidson and Stratton, the identifications were made entirely independently of theirs and in many cases differ materially from theirs. The writer is under deep obligation to Drs. Adams and Russell for putting the spectroscopic material at his disposal, and also to Miss Moore for the painstaking care with which her work was carried through.

In the material given in Table V, on account of restrictions of space, no more than three elements could be listed. The elements

are arranged according to their importance in the flash spectrum, the most important element being placed first. In *Handbuch der Astrophysik*, **4**, 289, is given 100 A of the flash spectrum beginning with λ 4383. The material is there published in the manner that the writer would have liked to adopt for the whole of the flash spectrum. On account of the high cost of printing, however, it has become necessary to omit all of the material included in the three columns giving the designation of the multiplet group in each case, together with King's arc intensities and temperature classes.

In giving at most three sources for each line, it is felt that no identification of any practical value is omitted. For a very large majority of the lines of the flash spectrum it would make little difference in the final conclusions if all sources were omitted except the first. It should be emphasized again that the order of the elements in Table V is according to their importance in the flash spectrum and not that of the Fraunhofer spectrum. The identifications of the present discussion were practically completed before the appearance of the *Revised Rowland* and are therefore independent of the solar identifications. Naturally, when the *Rowland Tables* appeared, detailed comparisons were made.

A comparison of the wave-lengths in chromosphere and sun as given in the first two columns of Table V will show that the average difference is about 0.03 A to the violet of λ 5900, but is about 0.05 A for longer wave-lengths. This degree of accuracy has permitted the identification of sources which it is hoped will be found to be reliable.

COMPARISON OF SPECTRA OF α PERSEI AND CHROMOSPHERE

A noteworthy publication has appeared from the hands of Dr. Theodore Dunham entitled, "The Spectrum of Alpha Persei," *Contributions from the Princeton University Observatory*, No. 9, 1929. The photographs were taken with the 15-foot auto-collimating spectrograph at the coudé focus of the 100-inch reflector at Mount Wilson, the dispersion at Hγ being 2.9 A per millimeter. The published wave-lengths have a probable error of about 0.02 A.U. at λ 4250 and 0.09 A.U. at λ 6200. According to the *Draper Catalogue*, the spectrum of α Persei is classed as F5. The spectrum of the chromosphere

is of earlier type than that of the sun, and, according to the estimation of Miss Annie J. Cannon, it may be as early as Fo. Hence, the type of α Persei is intermediate between the chromosphere and the sun. The stellar spectrum closely resembles the chromosphere in the great strength of the enhanced lines, with the result that comparisons between the two spectra will be of great interest. According to Dunham, the spectrum of α Persei has lines which are wider and deeper than are found in the sun.

The methods followed in the discussion of the stellar spectrum are identical with those carried out for the chromosphere in the present publication. While at Mount Wilson the writer saw the original plates of α Persei and was delighted to see the superb definition and dispersion. In the stellar spectrum, the region of wave-lengths discussed is from λ 4147 to λ 6678. Within this portion of the spectrum, there are 50 per cent more lines included in Table V for the chromosphere than are found in the spectrum of the star. In the region from λ 4147 to λ 4599, where the dispersion of the stellar spectrum is about four times as great as that of the chromosphere, there is a total of 509 lines in the star against 643 in the chromosphere, or 25 per cent more lines in the flash spectrum. In spite of the greater number of lines in the chromosphere there are some lines in α Persei which are not found in Table V, most of the lines however being weak.

When comparing the identifications in the two spectra, a surprising degree of agreement is found in the assignment of sources to the metallic lines. There are naturally many differences of opinion, but taken as a whole these are of minor importance. In his published results Dunham has had the advantage of being able to present in printed form all of his evidence for the identification of each line. Hence, when investigating the spectrum of the chromosphere, in the region common to the two spectra, one should at all times refer to the excellent material given in Dunham's valuable tables. It hardly need be remarked that many systematic differences are to be expected between Dunham's conclusions and those found in Table V. Part of the systematic effects are the result of differences in spectral type between chromosphere and α Persei; part come from the enormous differences in the spectra investigated. In one there is an emis-

sion spectrum with the constant dispersion of a normal scale. With *α* Persei the prismatic spectrum has a much greater dispersion at the violet end but smaller at the red end than was used with the chromosphere, while the photographs are the absorption spectrum of a star with a reversing layer much more extended than is found with the sun. It should further be added that the third or fourth source of identification for a line in the chromosphere was frequently omitted. Table V should therefore be interpreted to mean that it includes the most important identifications, but with the weaker and less important sources purposely omitted.

BLENDED LINES

The scale of the flash spectrum is approximately 1 mm = 10.8 A. Lines separated with large dispersion in the solar spectrum are blended in the smaller scale of the flash. As usual, there presents itself the problem of knowing what wave-length must be adopted for the solar line. The rule followed in the blend of two solar lines was to take the mean of their wave-lengths, giving weights equal to their Rowland intensities. If the intensity of one line was 0, then one unit was added to the intensity of each line. For instance, if the Rowland intensities of two blended lines were 0 and 2, then the wave-length was derived by giving weights of 1 and 3 to the two lines under discussion. It hardly need be remarked that this method of deriving the wave-lengths of blended lines is open to many criticisms. In the present case, the derived wave-lengths of the blended Rowland lines cannot be expected to furnish wave-lengths with the highest degree of precision for the lines of the flash spectrum. The ordinary solar spectrum is essentially an arc spectrum, while the flash spectrum, on the contrary, takes on the nature of an ionized or spark spectrum. The intensities of the solar and flash spectra are radically different, and hence there cannot possibly be an exact agreement in wave-length in blended lines from the two sources.

The rule adopted for deriving the wave-lengths is probably as good as any other, and it has been followed throughout the discussion. In some cases, however, it was realized that the rule would give inadequate wave-lengths. In these cases, comparatively few in number, two sources from Rowland are given in the table.

In the material in Table V, in the column headed "Disk," the designation such as 6^2 shows that two lines in Rowland are blended and that the sum of the individual intensities is 6.

INTENSITIES IN THE FLASH SPECTRUM

The scale of intensities employed in the present discussion is an arbitrary one, where 0 represents the weakest line visible while 200 is the strongest line, such as the K line or the $H\alpha$ and $H\beta$ lines of hydrogen. Investigations carried out in recent years have shown that the intensity of a spectral line on a photographic plate is dependent on many different factors. In addition to the intrinsic brightness of the line at its center must be added the effects from the width of the line, caused partly by a spreading of the photographic image. Russell, Adams, and Miss Moore[1] have shown that even the Rowland scale of intensities adopted in the *Revision* is itself not a constant one, lines of a given Rowland intensity representing a smaller true intensity in the red than in the violet. The Rowland scale is also an arbitrary one. On page 74 of the *Revised Rowland* the intensity of the K line of Ca^+ is given as 1000, while on page xv of the same publication the intensity of this same line is virtually assumed to be 200.

In the revision of the flash spectrum, the intensities were again independently estimated. The present scale is radically different from the one published earlier. After discussing the matter with Drs. Adams and St. John, it was decided to attempt to have the flash intensities on the same scale as that of Rowland. In the previous publication 100 was the maximum intensity in the chromospheric spectrum, but in the present discussion the maximum is 200 or equal to that of Rowland.

For many obvious reasons it is manifestly desirable for comparisons between the spectrum of the chromosphere and that of the sun to have one scale of intensities for both spectra rather than two, even though the two may be closely related. Any arbitrary scale of intensities, however, is probably very far from being a uniform scale. As already stated, the estimation of the intensity of a spectral line results from a combination of the blackness of the silver deposit on the photographic plate and the width of the line. In the flash spec-

[1] *Astrophysical Journal*, **68**, 1, 1928; *Mount Wilson Contributions*, No. 358.

trum, taken with or without slit, the intensity of any line on the photograph is affected by the number of lines blended together, that is, on the dispersion employed, and also to a very marked degree by the character of the seeing and the definition. It is readily seen also that the intensities of the chromospheric lines depend on the average level above the photosphere photographed. The metallic vapors are most intense at low levels near the photosphere. At the beginning of totality these low-lying intense levels become visible as soon as the moon covers up the photosphere, but they are covered up very rapidly by the advancing moon. The timing of the exposures for the flash spectrum is all important. The astronomer is in a very difficult position in attempting to photograph the flash spectrum. It may be his very first eclipse. With all of the excitement attending the unusual phenomenon, it is imperatively necessary that he must pull the string to begin the exposure (for the first flash) at exactly the proper instant. To begin too early will give a spectrum of the photosphere, while to begin too late will permit the low-lying and intense chromospheric levels to be covered. Unfortunately, there is no opportunity to rehearse; and moreover, the time of the beginning of the eclipse is very much complicated by the appearance of Baily's beads.

At one and the same eclipse and with exactly the same timing, different intensities will be found on the photographs depending on whether the spectrograph is used with or without slit. Without slit all levels contribute their emission to the spectral line, while with a slit only those levels covered by the slit give up their light to the line in question. Manifestly, the position of the image of the slit with respect to the photosphere is of prime importance, and also whether or not there is a prominence at the sun's edge where the slit is directed.

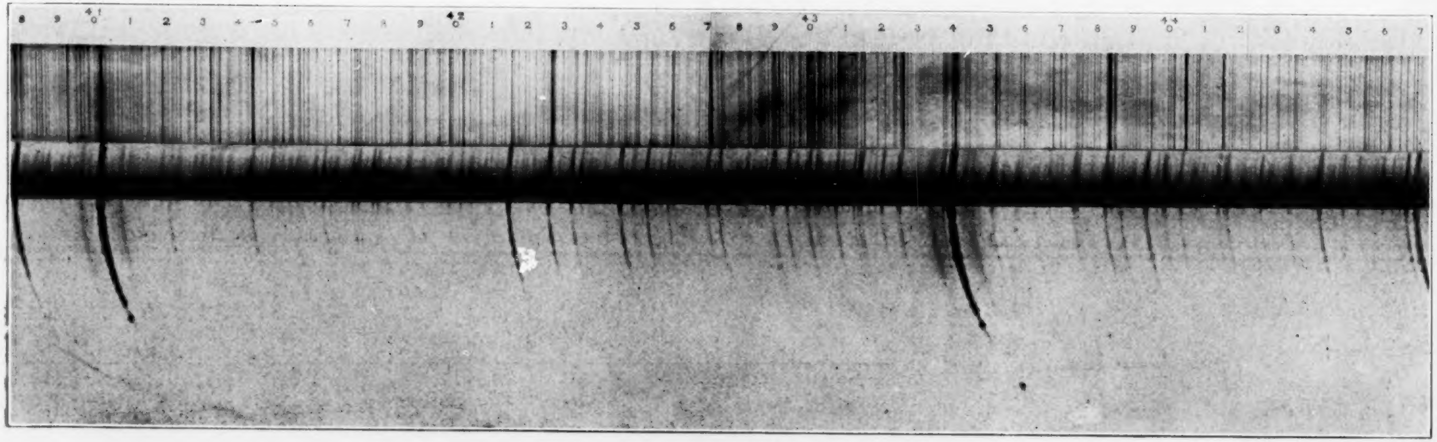
Hence there are many reasons why the intensities of the flash lines estimated from the photographs of any one eclipse may vary from photograph to photograph or from instrument to instrument. Even on the same photograph there are differences of intensities for the same line. Davidson and Stratton in their publication (*loc. cit.*) give the estimates at two different positions in their photographs called "flash" and "prominence," respectively. The differences observed by them may be attributed to differences in level.

The intensities of the spectral lines obtained at the eclipses of 1905 and 1925, both photographed by the writer with the same spectrograph, differ from each other, and in turn they both differ in many details from the intensities observed in the 1926 eclipse. One should be very guarded, when comparing one eclipse with another, in coming to the conclusion that differences in intensities between two eclipses may mean differences in solar activity. It is not impossible that the differences noted may find their true explanation in the differences of level photographed at the two eclipses.

In making comparisons between the flash spectrum and Rowland—particularly when comparing intensities of the two spectra—it should not be forgotten that the intensities in the two spectra are indeed very dissimilar. The great importance of the enhanced lines in the flash spectrum, the lines being greatly strengthened in the flash, makes it impossible for the scales in sun and flash to be alike for any single element appearing in both spectra. All one may do under the circumstances is to deal with averages. In the estimates of intensities for the present discussion, the average intensities were cared for mainly by having photographs of Rowland's *Atlas* reduced and the flash spectrum enlarged to the same scale as shown in Plate III. Lines of both spectra appear as dark lines on the print. Hence it was not a case of comparing intensities of absorption lines with those of emission lines, one dark and the other bright on the photographs. In all cases the present estimates of the 1905 and 1925 spectra are made from the original negatives. The reproduction on glass of the 1926 spectra, kindly furnished by Davidson and Stratton, permitted an independent estimate of the extreme ultra-violet. The overlapping of these spectra with the photographs taken by the writer permitted an estimation of all lines on a scale which it is hoped will be approximately uniform, or at least on the same average scale as Rowland.

The estimates of flash intensities were complicated by the increased strength of the enhanced lines in the chromospheric spectrum. The problem was specially troublesome at the violet end of the spectrum on account of the numerous strong enhanced lines found there. For these reasons there is a possibility that the scale of intensities may be systematically different at the violet end from the balance of the spectrum. It is believed, however, that the

PLATE III



COMPARISON OF FRAUNHOFER AND 1905 CHROMOSPHERIC SPECTRA

Above.—Rowland's Atlas reduced sixfold
Below.—Negative of eclipse spectrum enlarged fivefold

strength of the lines in the violet is underestimated rather than overestimated.

At the eclipse of June 29, 1927, Pannekoek and Minnaert[1] secured excellent photographs of the flash spectrum. In the discussion of these spectra, they were the first to measure the intensities of the flash-spectrum lines by the registering microphotometer, and by extended calibrations to reduce the measured intensities to absolute light units. The following is quoted from *Handbuch der Astrophysik*, **4**, 305:

> Comparisons were made with Rowland's intensities in the sun and with Kayser's intensities recorded in *Hauptlinien*. A satisfactory interpretation of these comparisons is encumbered with grave difficulties for the reason that the absolute scale of intensities derived from the microphotometer readings has no definite relationship with the arbitrary estimates by Rowland and by Kayser. On account of the many lines in the iron spectrum, comparisons were most complete for this element. Between the microphotometer intensities and Kayser there was shown to be a strong dependence on wave-length, a line at λ 4200 having a three-fold greater microphotometer intensity than a line of similar Kayser intensity at λ 4700.

Taking all of the foregoing facts into consideration, the writer has come to the conclusion that "it is always a question to know whether the gain in accuracy in measuring the intensities [in the flash spectrum] always pays for the extra labor involved, especially when the measured intensities must perforce be compared with estimated intensities in other spectra."[2]

LEVELS IN THE CHROMOSPHERE

If the flash spectrum is taken without slit, valuable information is obtained regarding the heights to which solar vapors extend above the photosphere. These elevations are among the most valuable pieces of information about solar activity that have been obtained from eclipse investigations that are available. These levels are derived from a measurement of the lengths of arcs forming each spectral line. The heights so measured are subject to many uncertainties. First of all, the lengths of the arcs on the photograph depend primarily on the definition, which again depends on the focus and

[1] *Verh. der Konikl. Akad. van Wet. te Amsterdam*, **13**, No. 5, 1928.

[2] *Handbuch*, p. 285.

seeing. The cusps fade off at their tips, and on the original photograph one can see the tip of the arc only to a certain threshold value on the plate. Needless to say, the better the definition of the spectra, the more hard and crisp are the chromospheric arcs, with the result that the farther out will the cusps be seen to extend. Hence the better the definition, or the better the qualities of seeing at the time of the eclipse, the longer will be the arcs of the chromosphere. Assuming that both the sun and moon are circular in outline, the heights to which the solar vapors extend can readily be calculated from the lengths of the chromospheric arcs. However, at the point of contact of the limbs of the sun and moon neither body is actually circular. The moon has mountains on it, while the sun's edge is disturbed by prominences, either one or other irregularity giving "Baily's beads." As is well known, these beads are usually visible at an eclipse, just before or just after totality. If the beads are seen at or near the point of contact where the flash spectrum appears, then their presence may greatly influence the lengths of the arcs of the chromospheric spectrum. One must be very cautious, therefore, in the interpretation of results.

By referring to Plates I and II, one may see the great difference in this respect in the eclipses of 1905 and 1925 in the character of the chromospheric cusps. The 1925 photograph shows no less than five Baily's beads near the point of third contact giving the second flash reproduced in Plate I. The 1905 eclipse had an entirely different peculiarity. No Baily's beads are seen near the middle of the arcs in Plate II though they are visible at several other places. In the low and medium levels, there is seen to be a more or less sudden termination of the arcs occurring at about the middle of the length of the line. All photographs taken both before and after the contact giving the flash spectrum reproduced in Plate II confirm the belief that a mountain on the moon, or rather a high plateau, was responsible for the interruption of the chromospheric arcs of the 1905 eclipse. Projected on the background of the sun, this plateau covered up the solar vapors extending about 600 km above the photosphere. As the distance to the moon is about one-four-hundredth of that to the sun, the height of the lunar plateau was 1.5 km, or about 1 mile.

Manifestly, as the definition of the 1905 spectra is better than

that of 1925, and, moreover, the arcs in the former spectra are not masked by Baily's beads, the estimation of heights is more reliable in the 1905 spectra.

In the region at the violet taken from Davidson and Stratton's publication, the heights given in Table V are those from the 1905 eclipse photographs, as already explained. Hence, the heights given in this table are mainly those of the 1905 eclipse.

In the earlier publication, the lengths of many of the chromospheric arcs were measured from a photographic enlargement on paper. At that time (1913) knowledge of solar levels had not the great importance it has today. In the present revision the original photographs were always used for measuring the lengths of the chromospheric arcs.

Great care was spent in the attempt to have the heights on as uniform a system as possible. For this purpose other photographs of the 1905 eclipse were used, in addition to the one from which the enlarged prints were made. The 1925 photographs were also made use of for this purpose in the region to the violet side of λ 6191 common to the 1905 and 1925 spectra. To the red side of this wavelength the heights manifestly depend only on the 1925 spectra.

Attention should be again called to the fact that the presence of a prominence at or near the point of contact of the limbs of the sun and moon, where the flash spectrum takes its origin, may greatly interfere with the precise determination of heights. Evidently a prominence of fair size at the point of contact would give entirely erroneous determinations of levels. If the flash spectrum is taken without slit, the arcs themselves show the prominences, and one may interpret the results in the light of this information. With spectra taken by the moving plate, one cannot judge from the spectra themselves whether the flash spectrum was secured at a disturbed region of the sun or at a portion representing average solar conditions.

At the 1905 eclipse, excellent spectra by means of a moving plate were secured by Campbell at Alhama, Spain, but a few miles distant from where the writer was located at Daroca. The Lick photographs made at third contact probably represent the flash spectrum taken at or near the same portion of the sun's edge as that photographed by the writer. The Lick measures should, therefore, give very reliable

values of elevations, referred, as they are, to an average section of the sun.

Photographs of the sun taken with the spectroheliograph show the presence each day of many prominences on the sun, the number depending on the state of solar activity. After an eclipse observer has selected his site, has erected his instruments, and has gone through the long and tedious job of adjusting his spectrograph, there is no choice left regarding the position angle on the sun where second and third contacts are to occur.

The Lick photographs of the 1905 eclipse are the only ones of first quality secured up to date with a moving plate. Observers of future eclipses must be on their guard in the interpretation of heights secured by this method in order to be sure whether the solar region photographed is in an average or a disturbed condition of activity.

DIFFERENCES BETWEEN THE ECLIPSES OF 1905 AND 1925

Between the wave-lengths λ 3300 and λ 5900 photographs were secured at each of the two eclipses with the same concave grating which gave a normal spectrum. Hence, comparisons between the two spectra have the ready advantage of not being disturbed by differences in dispersion. As already stated, there are many differences noted in intensities in the spectra of 1905 and 1925, which may be explained by variations of definition and seeing and by unequal timing of the exposures, resulting in differences in the levels photographed. With all of these variable factors to be reckoned with, it will be difficult to be sure whether correlations actually exist between the differences in the intensities of lines of the spectra noted at the two eclipses and changes in solar activity.

Do the changes in the activity of the sun,[1] as evidenced by sun-spots, manifest themselves in the chromosphere and the corona as well as in the photosphere? Astronomers have long been aware of an intimate connection between spots and the shape of the corona; the minimum of spots is characterized by the long equatorial extensions and the short polar brushes, while at sun-spot maximum the corona is more circular in outline. In addition to changes in the corona, it is evident that an increase in solar activity should cause the chromospheric vapors to be shot up to greater than average heights. If this

[1] Cf. *Handbuch der Astrophysik*, **4**, 157, 1929.

effect is large enough, it may possibly be detected by comparisons between the heights of the chromospheric gases found from the eclipses of 1905 and 1925. The former eclipse took place near maximum of spots while the latter occurred 1.5 years after sun-spot minimum. The corona of 1905 was of the typical maximum type, while that of 1925 departed little from the long equatorial extensions connected with minimum of spots. At the former eclipse there were many prominences visible to the naked eye bespeaking great solar activity. At the 1925 eclipse there were several small prominences visible with field glasses but none of them of sufficient size to be readily visible to the naked eye. All indications therefore pointed to much greater solar activity in 1905 than 1925.

When comparing the photographs of the flash spectra in the two years, it was with a great shock of surprise that one saw that the green coronium line at λ 5303 was much stronger in 1925 than in 1905. Moreover, the red coronium line at λ 6374 was very strong in 1925, even with the short exposures given for the flash spectrum. This line was not in the region photographed in 1905. It was first discovered at the 1914 eclipse, which took place eleven years previously and one year after sun-spot minimum. As has been pointed out in the *Handbuch der Astrophysik*, **4**, 338, the strength of the coronium lines in 1925 must be the result of great solar activity. This activity, unexpected so soon after minimum of spots, undoubtedly is caused by the new cycle of spots appearing in high northern and southern latitudes. This renewed solar activity manifests itself in changes in the shape of the corona. In fact, it has been found that the type of corona associated with the minimum of spots actually takes place about two years before the time of sun-spot minimum.

With the deeply rooted notions of a lifetime that spots are sure indications of solar activity, it was difficult to adjust one's mental processes to the continued surprises brought forth by the comparisons of the 1905 and 1925 spectra. In *Observatory*, **48**, 1925, the author made this remark:

> With the vapors of medium level there are vast differences in the lengths of the solar arcs in 1905 and 1925—in fact, the differences are so great that when the two spectra are compared side by side[1] they are evident even to a casual glance. When these lengths of solar cusps are translated into heights above the

[1] As is done in Plates I and II.

photosphere, it is found that the heights attained in 1925 are much greater than those of 1905.

It has been already pointed out that, with the flash spectrum disturbed by prominences, as evidenced by Baily's beads (cf. Plates I and II), it is manifest that the comparisons of two eclipses from the weaker low-lying lines will be subject to many uncertainties. In addition to the Baily's beads, the lengths of the chromospheric arcs depend on the timing and exposure of the flash spectrum, and on the character of the definition and seeing. With the stronger lines, which show longer arcs and are at higher levels, the uncertainties are much less. For the very strongest lines of the two spectra of 1905 and 1925, those that reach heights of 5000 km or more, there are no systematic differences between the two eclipses. The heights as determined from the 1925 spectra for these strongest lines, within errors of observation, agree with the values given in Table V, which correspond to the 1905 eclipse. For the lines of medium level, those [illegible] 800 and 2500 km, there were a total of 100 lines, whose heights were measured in the flash spectra of the two eclipses. Forty of these lines had an average height in 1905 of 1000 km, 32 an average height of 1500 km, 13 and 15 had average heights of 2000 and 2500 km, respectively. The comparisons are shown in tabular form.

COMPARISONS OF HEIGHTS IN 1905 AND 1925

Number of Lines	1905	1925
	km	km
40	1008	1665
32	1501	2438
13	2000	2885
15	2500	3733
First two groups, 72	1223	2006
Second two groups, 28	2268	3339
Total, 100	1519	2371

The photographs which give the foregoing measures are the second flash in each case, or those at third contact. From the tabular values it is seen that the heights in 1925 averaged roughly 50 per cent greater than in 1905. All of the hundred lines chosen for comparison took their origin from metals, either neutral or en-

hanced. In not one single case, in the hundred lines measured, was the height in 1905 greater than in 1925.

The measures of heights refer to the average condition of the chromosphere at or near the region on the sun where the flash spectrum was photographed. The chromosphere is not necessarily constant in depth. It is continually being disturbed by prominences, either small or large. It has repeatedly been compared to a "prairie fire." As already stated, the 1905 flash spectrum used for the comparison, as shown in Plate II, is undisturbed by prominences. The heights given in Table V therefore refer to an average quiescent condition of the sun. On the other hand, the 1925 flash spectrum given in Plate I was photographed in a region where small prominences were found, there being no less than five Baily's beads showing. It might be urged that the presence of these beads might cause a lengthening of the chromospheric arcs, especially if one of the beads [illegible] near one cusp. The lengths of the arcs would then have a systematic increase through a cause purely local. By selecting lines of medium level in the 1925 eclipse and giving a thorough study of the whole problem, it is believed that this criticism is obviated. There seems to be only one legitimate interpretation to make, which is that the average depth of the chromospheric vapors was greater in 1925 than in 1905.

Was this increased depth in 1925 representative of the whole sun, or was only that portion photographed in the flash spectrum at third contact the excited region? The presence of the prominences is proof of the sun's disturbed condition, at least locally, and hence it is not surprising to find the increased depth of the chromosphere at the 1925 eclipse.

Fortunately there are other photographs of spectra taken at both eclipses which may contribute their information. The photographs taken in 1905 near second contact were projected on a more disturbed region of the chromosphere than that of third contact representing the second flash. The levels derived from the first 1905 flash, however, agree nicely with those from the second flash, hence the levels in Table V probably represent average conditions for the whole sun for that eclipse.

The first flash in 1925 was at a less disturbed region of the sun

than that of the second flash, and the presence of three small prominences at the middle of the arcs in no wise complicated the measurement of the lengths. The depths of the chromosphere from the first 1925 flash are 15 per cent greater than those derived in 1905, and given in Table V. Apparently the depth of the chromosphere at the 1925 eclipse was not uniform, being less on the eastern edge of the sun at second contact than on the western limb. We also seem forced to the strange conclusion that, in the year 1925, near sun-spot minimum, the average heights to which the medium-level chromospheric vapors ascended were greater than in the year 1905 at the time of maximum of spots. If it had not been for the great strength of the coronium lines at the eclipse of 1925, it would have been thought that some gross blunder had been made.

Attention must be called to the obvious fact that the conclusions drawn from the flash spectrum regarding the activity of the sun in 1905 and 1925 can hold good only for the days of the two eclipses, and in fact even for the few short minutes of totality. One would be foolish to draw general conclusions from a study of a limited portion of the area of the sun.

In *Handbuch der Astrophysik*, **4**, 137, 1929, Abetti draws attention to the fact that the depth of the chromosphere is not constant but varies from place to place on the sun, depending on the solar activity. Somewhat similar disturbances are found in the corona. At the 1918 eclipse the corona was of very exceptional shape. Pettit and Miss Steele[1] found that the western side of the corona was of maximum type, while the eastern side was more nearly that associated with minimum of spots.

In dealing with the features shown in the 1925 eclipse and contrasting them with those in 1905, the following lines[2] were written:

> After passing through the minimum of spots, the awakened solar activity shows itself in three different portions of the sun: (1) In the photosphere, by its increased radiation, causing spots to appear. (2) In the chromosphere, the increased radiation carries the elements of medium height to greater average elevations. (3) In the corona, the increased radiation causes an increase in strength of the emission lines of coronium, and also makes the corona lose the shape associated with minimum of spots, of long equatorial extensions and short polar brushes.

[1] *Popular Astronomy*, **26**, 479, 1918. [2] *Handbuch der Astrophysik*, **4**, 352, 1929.

THE IMPORTANCE OF LEVELS IN THE INTERPRETATION OF SOLAR AND STELLAR SPECTRA

In 1913, in the discussion of the radial motions of sun-spots known as the Evershed effect, St. John called attention[1] to the great importance of knowing the heights above the photosphere at which lines of different intensities originate in the sun. In the same year, Mitchell[2] emphasized the importance of levels in the interpretation of his measures of the flash spectrum. In the year 1928, in discussing[3] the Einstein relativity shift observed in the sun, St. John states:

> The concept that the Fraunhofer lines in the spectra of the sun and stars refer to definite levels is steadily gaining acceptance and application. The observational evidence for this concept rests upon the concordant results from solar rotation, flow near spots, flash spectra, differences between the spectra of limb and center, progression in excitation potentials and the observed decrease in the general magnetic field with the heights above the photosphere at which the lines used have their origin.

The recent remarkable increase in knowledge regarding atomic structure coming from the discovery of series relationships in spectra, from which has sprung information regarding ionization and excitation potentials, has furnished a very powerful means for the interpretation of solar and stellar problems. Again to quote from St. John's 1928 publication (*loc. cit.*):

> The heights to which the constituents of the solar atmosphere rise are mainly determined by their abundance, atomic weight, ionization potential, and selective radiation-pressure; but for the same element, the levels registered by the normal lines depend on the excitation potential and the probability of the electron transitions concerned in their production. For an element in a given state of ionization, the lines of the multiplet of lowest excitation potential and, within the multiplet, the lines on the diagonal, due to transitions of greatest probability, represent the highest elevation above the photosphere. Since atoms in this state of excitation are the most numerous, form the most abundant constituent of the substances, and contribute most to their radiation or absorption, their lines will be strong and the level high. For each element the relation between level and line-intensity should hold for lines of the same class and spectral region, but lines of a given solar intensity corresponding to different elements, or classes, or spectral regions, are not necessarily at the same level.

[1] *Mt. Wilson Contr.*, No. 74; *Astrophysical Journal*, **38**, 343, 1913.

[2] *Astrophysical Journal*, **38**, 407, 1913.

[3] *Mt. Wilson Contr.*, No. 348; *Astrophysical Journal*, **67**, 117, 1928.

So far in the history of astrophysics the only means of directly measuring heights above the photosphere comes from eclipse photographs of the flash spectrum taken without slit. The heights recorded in Table V are subject to systematic errors of two different kinds. (1) What is the zero level to which they are referred? As already stated, the heights so measured need not necessarily refer to the level of the photosphere as origin but rather to some level lying close to the photosphere. But the question must be asked, "What is the photosphere?" Formerly it was thought that it had a more or less sharp edge, but ideas in recent years on this subject have been greatly modified. (2) The heights recorded cannot be the maximum heights to which atoms and their electrons are shot by solar activity. Heights, whether measured from eclipse spectra with moving plate or from the length of the arcs, as in the present publication, can correspond only to a certain minimum intensity on the photograph, depending on the threshold value for the plate and region of spectrum used.

The first systematic error can be cared for by adding a constant amount, probably less than 100 km, to all heights. For the second, it is only necessary to assume that the heights correspond to a certain average intensity of radiation in the chromosphere. Except at the ends of the spectra, conditions depending on the photographic plate or eclipse will be averaged out by combining the results of more than one eclipse, which has been done.

There are enormous differences in the appearances of the arcs shown by different lines of the flash spectrum. On the one hand, there are the short and intense arcs of low-lying gases. At the other extreme are faint arcs extending high in kilometers above the solar surface, such, for instance, as the He^+ line at λ 4686. This line has sufficient strength to show itself on the halftone illustration facing page 423, *Astrophysical Journal*, **38**, 1913. There is no gainsaying the fact that this is a high-level line. Indeed, it is difficult to explain how this line with excitation potential 48.16 volts can be found at all at solar temperatures.

IONIZATION AND EXCITATION POTENTIALS

It has been exceedingly interesting to see the manner in which the intensities and heights of lines belonging to any multiplet group

of any element arrange themselves about the diagonal of the multiplet. As a general thing, the atoms "play the game" by obeying the rules laid down for their behavior. In the following publication, where the elements will be discussed in detail, it will be shown that the strongest lines of any element belong to the multiplets of lowest excitation potential. There are some apparent exceptions to this rule. For instance, in the spectrum of Ti^+, the ultimate lines[1] of excitation potential 0.00 belong to quartet systems. None of these lines is as strong, nor do they extend so high, as lines of the doublet systems of excitation potential 0.59 with wave-lengths 3685, 3759, and 3761, all extending to 6000 km.

Any interpretation of solar phenomena must assume that chromospheric gases are densest and atoms most numerous at low-lying levels, with the atoms becoming less and less numerous at higher elevations. The effects of this concentration will vary greatly depending on whether the spectral lines are viewed tangentially, as in eclipse spectra, or radially at the center of the sun's disk, as in the ordinary solar spectrum. For instance, a beam of light from the bottom of a shallow layer only 500 km in thickness will encounter a total length of no less than 25,000 km of emitting atoms in the tangential line of sight before getting out of the shallow layer; but will encounter only 500 km of absorbing atoms in the ordinary solar spectrum. The flash spectrum gives a cross-section of the emitting layers while in the absorption spectrum the same layers are viewed from above. The intensity scale of the chromosphere should therefore be more sensitive to changes depending on level than are the ordinary Rowland intensities. Moreover, the Fraunhofer spectrum results from the differences between photospheric conditions of temperature, pressure, etc., and those of the chromosphere. In eclipse spectra the photosphere is covered up and the spectrum of the chromosphere is itself revealed separated from the photosphere.

The differences in intensities between chromosphere and solar spectrum coming from these two causes vary from element to element, and from multiplet group to multiplet group. The greatest differences are found in the element helium. There are 18 lines of normal helium and 1 of He^+ found in the flash spectrum, with none

[1] Russell, *Mt. Wilson Contr.*, No. 286; *Astrophysical Journal*, **61**, 47, 1925.

in the solar spectrum. In the flash spectrum 33 lines of the hydrogen series were measured. With Ti^+ the maximum intensity in the solar spectrum is 12, while in the flash spectrum with approximately the same average scale of intensities the maximum strength is 80.

GENERAL CONCLUSIONS[1]

1. The Fraunhofer spectrum is essentially an arc spectrum. The chromospheric spectrum more closely resembles the spark spectrum, and it corresponds to an "earlier" type than that of the sun.

2. With the maximum dispersion used up to the present at eclipses, it is impossible to detect any systematic differences in wave-length between chromosphere and sun.

3. The flash spectrum must be regarded as a reversal of the Fraunhofer spectrum.

4. The chromospheric spectrum, however, differs greatly from the ordinary solar spectrum in the intensities of the lines.

5. Especially prominent in the chromosphere are the enhanced lines.

6. The enhanced or ionized lines ascend to greater elevations than do the ordinary or normal lines of the same element. The increased elevations cause rapidly diminished pressures, permitting ionization to take place more freely in accordance with Saha's theory of ionization.

7. The great importance of levels in the interpretation of solar and stellar spectra has been generally recognized.

8. A knowledge of ionization and excitation potentials is essential to a thorough study of solar and chromospheric spectra.

9. For each element in any given state of ionization there is a close connection between intensities and heights.

10. For each element the strongest lines, which extend to greatest heights, usually belong to the multiplets of lowest excitation potential.

11. The greatest heights in the chromosphere are reached by Ca^+ at 14,000 km and by $H\alpha$ of hydrogen at 12,000 km.

12. Comparisons between the 1905 and 1925 spectra, each photographed with the same grating spectrograph, show interesting dif-

[1] Cf. *Handbuch der Astrophysik*, **4**, 311, 1929.

ferences. For the lines of greatest level, those reaching 5000 km or more, there are no systematic differences between the two years. For lines of medium level, those lying between 1000 and 2500 km, the heights reached in 1925 were greater than in 1905 in spite of the fact that the 1905 eclipse was near maximum of spots while the later eclipse was near spot minimum.

13. These differences, together with the fact that the emission lines of coronium were stronger in 1925 than in 1905, seem to prove that although the 1925 eclipse was only 1.5 years after sun-spot minimum, there must have been great activity on the sun emanating from the new cycle of spots in high northern and southern latitudes.

14. It is important to continue observations of the flash spectrum at future eclipses, securing the best definition, the greatest dispersion, and the maximum range of wave-lengths possible. Microphotometric observations to determine line contours will be specially valuable.

DISTINCTION BETWEEN SCATTERING AND ABSORPTION

By JOHN Q. STEWART and SERGE A. KORFF

ABSTRACT

An experimental method is described which is capable of distinguishing scattering from absorption in the formation of dark lines when light is transmitted through a vapor. When applied to *Na* vapor, the result found was that scattering predominates at the edges, but that absorption is occurring in the cores. Possible explanations are mentioned, but no final theory advanced. The bearings on the contours of Fraunhofer lines and on the spectroscopic analysis of planetary atmospheres are briefly discussed.

Common usage denotes as "absorption lines" the dark lines observed in the spectrum of white radiation that has traversed a gas. In the case of sodium vapor, however, it has been shown experimentally that, at the edges of the D lines, scattering is the primary process in producing the opacity.[1] The opacity here results from diffusion of the original radiation in a variety of directions, the energy not being transformed into other forms, such as heat, and the frequency of the radiation remaining unaltered.[2]

It makes no difference whether this happens according to the classical picture involving vibrating bound electrons, or according to a quantum model which only permits an atom to change to a state of higher energy and then return, emitting the light in general in a new direction. The effect is that the light is diverted from the primary beam and scattered in all directions (although of course not necessarily with equal intensities in all directions).

Absorption, on the other hand, is associated with transformation of the original radiation into other forms—usually, we suppose, into heat in the gas. This distinction between scattering and absorption is not employed by some writers.[3]

The "artificial planet"[4] provides an experimental method for dis-

[1] A. S. Fairley, *Astrophysical Journal*, **67**, 114, 1928; J. Q. Stewart and S. A. Korff, *Physical Review*, **32**, 676, 1928; in particular, S. A. Korff, *ibid.*, **33**, 584, 1929; **34**, 457, 1929.

[2] R. W. Wood, *Physical Optics*.

[3] A. S. Eddington, *Monthly Notices of the Royal Astronomical Society*, **89**, 621, 1929.

[4] J. Q. Stewart and S. A. Korff, *Popular Astronomy*, **37**, 390, 1929.

tinguishing opacity produced purely by scattering from opacity due to other causes. Sodium vapor was formed in a cylindrical shell of glass, of length many times its diameter, and with the ratio of inner to outer diameter as near unity as convenient—in other words, an unsilvered Dewar flask. One such shell measured 20 cm in length, with diameters 3.0 and 2.6 cm.

The shell was mounted inside a white box, which also contained several powerful incandescent electric bulbs, so that the cylinder was strongly illuminated more or less uniformly from all external directions. The shell had previously been evacuated, and solid sodium had been introduced. Evaporation resulted from heat applied through current in a long cylindrical coil of wire inserted into the inner open cylinder. This coil was removed when sufficient heat had been applied. A spectroscope was arranged to view the sodium vapor in the shell, the eye-end of the spectroscope projecting through the box and through a partition into a dark room.

When the central cylinder was left empty and the lights extinguished on the side of the box near the slit of the spectroscope, the sodium vapor was viewed with transmitted light, and the usual dark D lines naturally appeared, against the continuous background of color due to the incandescent lights on the opposite side of the transparent shell.

When the inner surface of the shell was made reflecting by inserting either a white cylinder or a silvered glass rod inside the open central cylinder, and all the lights in the box turned on, the cores of the D lines remained dark, although bright wings appeared when the vapor density was sufficiently high (at about 300° C.). (No special precautions were taken to purify the sodium, and in a few minutes the glass walls became darkened within. Several different shells were employed, with consistent results throughout.)

The obvious conclusion is that although scattering is the important process operative at the edges of the D lines, absorption or something like absorption must be occurring in the cores. This is the case because, if scattering were the only process throughout, the vapor would, in the D wave-lengths, especially at the cores, be a better reflector than the inner white surface. (A gray or black inner surface was also used at times, with the same resultant appearance

of the D lines—dark cores, bright wings.) The well-known treatment by Schuster[1] indicates that in such a case as this "artificial planet" the vapor, being practically opaque to transmitted light in the D wave-lengths, should be in the same wave-lengths a very good diffuse reflector. The radiation cannot go through, and if absorption were absent would practically all be returned to the outside.

It is true that the dark D lines are less intense when viewed in the manner just described by reflected light (instead of by light that has undergone only one transmission), as their edges disappear or even show as bright. This effect may be of significance in estimates of the mass of oxygen, for example, in the atmosphere of Mars, based on just such spectroscopic conditions.

From what is known of the spectroscopic nature of the oxygen bands in question, however, it appears plausible to assume that the diverted radiation is not truly scattered but is re-emitted in a different wave-length. More data are required; meanwhile, it remains barely possible that more oxygen and water vapor exist on Mars than has been supposed.

The glass walls of the cylindrical shell in the present experiment may introduce some spurious effect which gives pure scattering the appearance of absorption—but there is no reason to suppose this.

The cause of the central absorption remains to be sought. That scattering cannot be the only process throughout the line is evident from thermodynamic considerations.[2] The usual supplement offered is based on some effect of collisions.[3] This may be a sufficient answer in the laboratory tests described in the present paper; further study is required. Unless collisions per atom occur with a frequency approximating the classical damping factor, of the order $4\pi^2 a\nu/\lambda$ (where a is 1.88×10^{-13} cm, the "radius of the electron"; ν is the frequency; and λ the wave-length of the light), it is difficult to un-

[1] *Astrophysical Journal*, **21**, 1, 1905.

[2] J. Q. Stewart, *Monthly Notices of the Royal Astronomical Society*, **85**, 738, 1925. A previous paper (*Astrophysical Journal*, **59**, 30, 1924) deliberately restricted the application of scattering formulae to the edges of Fraunhofer lines.

[3] A. Unsöld, *Physical Review*, **33**, 268, 1929.

derstand how they can be effective. For the D lines this frequency is 6×10^{7} sec.$^{-1}$. At the high density (order 3×10^{14} atoms per cubic centimeter) of the sodium vapor in the "artificial planet" each sodium atom would collide as often as 6×10^{7} times per second, only if its "collision radius" were greater than 10^{-6} cm. Again, only a fraction of all collisions may be effective in disturbing the radiating electron in the atom.

The "thermal" speed of an atom is given by $\sqrt{3kT/m}$, where m is its mass, T the temperature, and k is Boltzmann's constant, while the free path is of the order $1/\pi r^2 n$, where there are n atoms per unit volume having "collision radii" r.

According to H. N. Russell's detailed study,[1] the number of atoms of all kinds per square centimeter column in the solar atmosphere is of the order 3×10^{21}. If these are spread through a thickness of 100 km, the average density is about that of the sodium atoms alone in the present experiment. Owing to the higher temperature, collisions would then be occurring several times more frequently than in the cylindrical shell.

When collisions occur relatively frequently, the normal line width due to the intrinsic lack of tuning at infinite rarefaction is broadened, as Lorentz has calculated and the well-known experiments of C. Fuchtbauer[2] and his collaborators have demonstrated. There is no indication of such broadening in the experiment at present under discussion—nor did Unsöld[3] find such indication in his application of the equations of resonance scattering to measurements of actual contours of the edges of Fraunhofer lines.

A process qualitatively capable of producing something like absorption at infinite rarefaction has been indicated by J. Q. Stewart.[4] It does not depend on collisions, but on the diffusion in frequency in scattering resulting from the Doppler effect of the thermally agitated atoms in a gas—a process far more effective here than the Compton effect. A quantitative formula is lacking, however.

[1] *Astrophysical Journal*, **70**, 63, 1929.

[2] *Annalen der Physik*, **71**, 222, 1923, etc.

[3] *Zeitschrift für Physik*, **46**, 765, 1928.

[4] *Popular Astronomy*, **36**, 345, 1928.

Further theoretical and experimental work is necessary before a satisfactory physical treatment of the formation of the cores of Fraunhofer lines can be formulated.

The construction of apparatus described above was facilitated by a grant from the Carnegie Corporation through the Carnegie Institution of Washington.

PRINCETON UNIVERSITY
December 3, 1929

MINOR CONTRIBUTIONS AND NOTES

IDENTIFICATION OF *Al* III AND OF *Al* II IN STELLAR SPECTRA

ABSTRACT

Five previously *unidentified lines* in the star 88 γ Pegasi, of spectral type B2, are found to be due to *doubly ionized aluminum*. These lines reach maximum intensity between types B1 and B2, in agreement with their potentials of ionization and excitation. Several lines measured by the late F. E. Baxandall in α Cygni may be *attributed to singly ionized aluminum.*

The line spectra of *Al* III and of *Al* II have been investigated in the laboratory chiefly by F. Paschen[1] and classified according to their respective series. The ionization potentials of the aluminum atoms of various stages of ionization are: *Al* I, 6.0; *Al* II, 18.7; *Al* III, 28.3 volts. The excitation potentials of the lines of *Al* II and of *Al* III situated in the ordinary photographic region of the spectrum are also rather high. Consequently it is obvious that these lines should appear only in the hotter stars. The lines of neutral aluminum are, of course, well known in the sun and in the cooler stars. The ultimate lines at λ 3944 and λ 3961 are among the strongest in the solar spectrum.

I have recently measured a number of fairly strong lines in the spectrum of the star 88 γ Pegasi, of spectral type B2. None of these lines had previously been identified. Upon comparing my stellar wave-lengths with those given by Paschen, it became evident that the *Al* III lines are present in this star. The wave-lengths of all lines so far identified are shown in Table I. The stellar spectrogram used had a dispersion of 10 A per millimeter at λ 4500. In order to secure the best possible results the fine-grained Eastman Process emulsion was used. The measurements were made in the usual way against a comparison spectrum of *Ti*. The wave-lengths derived were corrected for the radial velocity of the star, which had been obtained from 31 stellar lines of *H*, *He*, *O* II, *N* II, *Mg* II, and *Si* III. The region of

[1] *Annalen der Physik*, **71**, 142 and 537, 1923. R. A. Sawyer and F. Paschen, *ibid.*, **84**, 1, 1927; H. N. Russell, *Nature*, **113**, 163, 1924.

good definition on my plate extends from about λ 4370 to λ 4700. All of the lines given by Paschen, in this interval, have been identified in the star.

It may be noted that for the violet part of the spectrum Paschen lists only two strong lines, whose existence might be tested with a spectrograph of smaller dispersion. However, both lines are blended in stellar spectra: λ 4188.88 is blended with an *O* II line, while λ 4199.00 is rather close to a line of *He* II.

The new *Al* III lines have been observed in many stars. They appear to reach maximum intensity between spectral types B2 and B1. They are strong in γ Pegasi and perhaps even a little stronger

TABLE I

LINES OF *Al* III

Wave-Length (Paschen)	Intensity (Paschen)	Wave-Length (Star)	Intensity (Star)
4479.891	3	4479.98	6
4479.968	4		
4490.90	2	4491.19	1
4512.535	4	4512.64	4
4528.911	1	4529.21	5
4529.176	6		
4701.65	6	4701.25	3

in ε Canis Majoris, of type B1. In class B5 these lines are very faint. In O9 they can barely be seen on some of the best plates.

There is a small systematic difference, amounting to nearly 0.1 A, between the wave-lengths obtained from the stellar spectrum and those of Paschen. This difference seems to be real, especially if the last line is omitted as being outside the region of best definition of the plate. Wave-lengths of lines due to *O* II and to other elements gave a similar scattering, but in the mean they agreed well with the laboratory determinations. The difference noted for *Al* III may perhaps be caused by relative motions of the gases in the star—a sort of convection effect similar to that discovered by St. John and Adams in other stars; but it seems unprofitable to follow this suggestion further at present.

The existence of *Al* III lines in type B2 suggested that some of the lines of *Al* II might be found in intermediate types, say B9 or A0. A

comparison of Paschen's wave-lengths with unidentified stellar lines in α Cygni and in β Orionis, measured by the late F. E. Baxandall,[1] shows that *Al* II is almost certainly present. Table II contains all lines listed by Paschen, in the photographic region of the spectrum, for which he gives the intensity as 4 or stronger. Nearly all of these lines are accounted for in α Cygni. Some of them have been identified by Baxandall with other elements and may in reality be

TABLE II

LINES OF *Al* II

Wave-Length (Paschen)	Intensity (Paschen)	Wave-Length (α Cygni)	Intensity (α Cygni)	Wave-Length (β Orionis)	Intensity (β Orionis)
3900.680	10	Blend	....	....	....
3995.860	5	3995.7	<1	Blend	....
3996.156	4				
4226.812	6	Blend	....	....	....
4227.493	5				
4227.982	4				
4347.794	4	....	....	Blend	....
4347.785	4				
4585.820	6	4586.0	<1	....	....
4588.194	5	Blend	....	Blend	....
4589.750	4	Blend	....	....	....
4640.373	4	4641.1	<1	....	....
4640.362	4				
4663.054	10	4663.8	2	4662.8	1

blends. However, the strong line at λ 4663 is obviously due to *Al* II, and was indeed suspected by Baxandall as being due to "proto-aluminum."

The astrophysical behavior of aluminum appears to be very similar to that of silicon. The first three stages of ionization for both elements reach maximum intensity at nearly the same points in the sequence of stellar spectra. For silicon we know also the third stage of ionization, but this has not thus far been discovered for aluminum.[2]

OTTO STRUVE

YERKES OBSERVATORY
January 20, 1930

[1] *Catalogue of 470 of the Brighter Stars Classified According to Their Chemistry* (Solar Physics Committee, London, 1902). *Comparison of the Spectra of Rigelian, Crucian, and Alnitamian Stars* (Solar Physics Committee, London, 1914).

[2] After this paper had been sent to press, I found that P. W. Merrill had observed several aluminum lines *in emission* in the spectrum of the star B.D.+11°4673 (*Astrophysical Journal*, **69**, 357, 1929). All the lines observed by me were *in absorption*.

A NOTE ON THE SPECTROSCOPIC OBSERVATION OF ECLIPSING BINARIES

ABSTRACT

It is suggested that spectrographic observations of eclipsing binaries may be more easily obtained in the *red portion of the spectrum*, where the *difference of luminosity* between the component stars is usually *less* than at λ 4500.

Eclipsing binaries of the "giant and dwarf" type, which comprise the great proportion of the known variables of this class, because their deep primary minimum makes discovery more likely, have been very difficult objects to attack spectrographically. This is because of the faintness of the secondary spectrum, which is rarely visible at all. It seems probable, however, that these stars might be

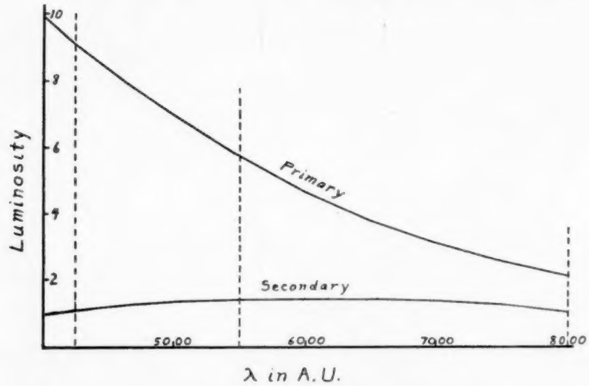


FIG. 1.—Curves showing variation of luminosity with wave-length for primary and secondary stars.

successfully observed in the deep red. There are twenty or thirty stars of this type for which photometric solutions have been made, so that spectrographic observation would unlock a veritable storehouse of information on masses, densities, and luminosities. The magnitudes range from the fifth to the tenth at maximum light, the minima being perhaps 2 magnitudes fainter.

The surface temperatures of stars of this type range from 10,000° to 20,000° for the primary, the secondaries having about half the surface temperature of the primary in the average case. The ratio of the visual luminosities is usually about 5 to 1.

Figure 1 shows the variation with wave-length of the mono-

chromatic luminosities of two stars whose surface temperatures are 10,000° and 5000° for the primary and secondary stars, respectively, as computed by Planck's Law. The scales are so adjusted that the visual luminosities are in the ratio of 4 to 1.

The ratio of luminosities is 7 to 1 at the region usually central for spectrographic observation, λ 4500. If 80 per cent of the light of the secondary star were obscured by an absorption line of this wave-length, the decrease in the total light would be only 10 per cent, and the line would be below the limit of observable contrast. At λ 8000, on the other hand, the ratio of intensities is only 2 to 1, and an absorption line of similar depth in the light of the secondary star would have a depth of 27 per cent of the total light, and a far better chance of being measurable.

EUGENE W. PIKE

PRINCETON UNIVERSITY OBSERVATORY
January 8, 1930

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The present sheet has been printed for amplifying further that paragraph.

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As to illustrations, the arrangements cannot be quite as specific, but it may be generally assumed that not more than three halftone inserts can be allowed without payment by the author. The cost of paper, presswork, and binding for each full-page insert is about $8.00, aside from the cost of the halftone itself. In the matter of zinc etchings, considerable latitude has to be allowed, as in many cases diagrams take the place of more expensive tables. It may be assumed, however, that it will seldom be possible for the *Journal* to bear an expense of over $25 for diagrams and text illustrations in any one article.

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Reprints of articles, with or without covers, will be supplied to authors at cost. No reprints can be furnished unless a request for them is received before the *Journal* goes to press.

Every article in the *Astrophysical Journal*, however short, is to be preceded by an abstract prepared by the author and submitted by him with the manuscript. The abstract is intended to serve as an aid to the reader by furnishing an index and brief summary or preliminary survey of the contents of the article; it should also be suitable for reprinting in an abstract journal so as to make a reabstracting of the article unnecessary. For details concerning the preparation of abstracts, see page 176 in the September, 1928, number of the *Journal*.

THE EDITORS